THE SETTING OF THE ANNUAL SUBSISTENCE HARVEST TAKE RANGES OF NORTHERN FUR SEALS ON THE PRIBILOF ISLANDS FOR THE PERIOD 2003-2005

ENVIRONMENTAL ASSESSMENT

April 2003

Lead Agency:	**National Oceanic and Atmospheric Administration** **National Marine Fisheries Service** **Alaska Region** **Juneau, Alaska**
Responsible Official:	**James W. Balsiger** **Administrator** **Alaska Region**
For Further Information Contact:	**Alaska Regional Office** **National Marine Fisheries Service** **P.O. Box 21668** **Juneau, Alaska 99802** **(907) 586-7235**

THE SETTING OF THE ANNUAL SUBSISTENCE HARVEST TAKE RANGES OF NORTHERN FUR SEALS ON THE PRIBILOF ISLANDS FOR THE PERIOD 2000-2002

ENVIRONMENTAL ASSESSMENT

April 2003

Lead Agency:	**National Oceanic and Atmospheric Administration** **National Marine Fisheries Service** **Alaska Region** **Juneau, Alaska**
Responsible Official:	**James W. Balsiger** **Administrator** **Alaska Region**
For Further Information Contact:	**Alaska Regional Office** **National Marine Fisheries Service** **P.O. Box 21668** **Juneau, Alaska 99802** **(907) 586-7235**

Abstract: Regulations at 50 CFR 216.72(b) require the Assistant Administrator for Fisheries to determine and publish the take ranges for the Pribilof Islands subsistence harvest of northern fur seals every three years. The purpose of this proposed action is to set the annual Pribilof Islands fur seal subsistence take ranges for the period 2003--2005 as required by regulations. This action establishes the number of northern fur seals on the Pribilof Islands that may be taken by Alaskan Native (Aleut) residents annually for the three year period 2003-2005. This action maintains the same take ranges that were established for the previous three year period 2000 - 2002. The current range for St. Paul Island is 1,645-2,000 seals; the range for St. George Island is 300-500 seals. These ranges, through close consultation with the Tribal Governments of St. Paul and St. George Islands, have been determined as adequate to meet the local subsistence needs for Aleut community living in the Pribilof Islands.

This Environmental Assessment results in a significant cumulative effects finding. Therefore, preparation of an environmental impact statement for the proposed action is required by NEPA regulations at Section 1501.4(c). The significant cumulative effects on northern fur seals include the negative effects of environmental shifts that may affect prey, the potential effects of commercial fishing on the availability of fur seal prey based primarily on the overlap of the groundfish fisheries with fur seal foraging ranges, and on the lack of information from the groundfish fisheries that food availability to fur seals is not related to recent population declines.

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

AA	Assistant Administrator for Fisheries
ANO	Alaskan Native Organization
BSAI	Bering Sea and Aleutian Islands
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CZMA	Coastal Zone Management Act
EA	Environmental Assessment
EBS	Eastern Bering Sea
EIS	Environmental Impact Study
E.O.	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act, as amended
FONSI	Finding of No Significant Impact
FSA	Fur Seal Act
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
RFA	Regulatory Flexibility Act
U.S.C.	United States Code
MNPL	Maximum Net Productivity Level
FR	Federal Register
K	Carrying Capacity
P.L.	Public Law

Executive Summary

Description of the Proposed Action

The commercial harvesting of northern fur seals *Callorhinus ursinus* on the Pribilof Islands, Alaska, began shortly after the discovery of the Islands in 1786. The commercial harvest was continued by the United States when the Pribilof Islands came under U.S. jurisdiction with the purchase of Alaska from Russia in 1867. On October 14, 1984, the Interim Convention on the Conservation of Northern Fur Seals, which authorized the commercial harvest, expired and the U.S. Congress failed to ratify a new treaty extension. Since domestic law did not provide for a commercial harvest of marine mammals in the U.S., the commercial harvest of northern fur seals was terminated.

On July 9, 1985, the National Marine Fisheries Service (NMFS) published an emergency interim rule to govern the subsistence taking of fur seals by Alaskan Native (Aleut) residents of the Pribilof Islands under authority of section 105(a) of the Fur Seal Act (FSA). A final rule was subsequently published on July 9, 1986 (51 FR 24828). The subsistence harvest of northern fur seals on the Pribilof Islands is governed by regulations at 50 CFR 216 Subpart F--Pribilof Islands, Taking for Subsistence Purposes. These regulations were published under the authority of the Fur Seal Act (FSA), 15 U.S.C. 1151 et seq., and the Marine Mammal Protection Act (MMPA), 16 U.S.C. 1361 et seq. (see 51 FR 24828, July 9, 1986).

The current proposed action is to set the annual Pribilof Islands fur seal subsistence take ranges for the period 2003 - 2005 as required by regulations at 50 CFR 216.72(b). This action continues the process begun in 1986 and modified in 1994, and will establish the number of seals that may be taken by Alaskan Native (Aleut) residents annually for the three year period 2003 - 2005 on the Pribilof Islands. This is a "status-quo" proposed action that proposes no changes and maintains the same take ranges as were established for the previous three year period 2000 - 2002. These levels of take have been determined as adequate to meet the local subsistence needs for northern fur seals.

Alternatives Considered

The following two alternatives have been identified regarding this action:

Alternative 1: Propose that the annual take ranges for the subsistence harvest of northern fur seals on the Pribilof Islands be set at levels different from, either greater or lesser than, those established in 1997 and 2001.

Alternative 2: Propose that the annual take ranges for the subsistence harvest of northern fur seals on the Pribilof Islands be set at the same levels as those established in 1997 (status quo). This is the Preferred Alternative by NMFS and the alternative recommended by the Tribal Governments at this time.

Summary of Major Environmental Impacts

(I) Direct and Indirect Effects of Alternatives

The preferred alternative would have no affect on other wildlife. The proposed action is limited to a harvest of fur seals on rookeries. No endangered or threatened species or their critical habitat will be affected by this action.

The preferred alternative would meet the documented subsistence needs of the Aleuts on St. Paul and St. George Islands and is consistent with MMPA Federal law.

The proposed actions promote cultural diversity and recognizes the importance of maintaining traditions for Alaska native groups. The proposed action does not set any precendent that could increase the subsistence hunting pressure on northern fur seals.

The preferred alternative would not have a significant impact on the general public.

The proposed actions will not cause substantial damage to the ocean or habitats, or to Essential Fish Habitat (EFH). There is no incidental take of other species during the harvest. The level of harvest is not inhibiting the increase of this population.

The preferred alternative will set the number of fur seals to be taken for subsistence purposes on St. Paul Island at the current level of 1,645-2,000 seals. The preferred alternative will set the number of fur seals to be taken for subsistence purposes on St. George Island at the current level of 281-500 seals. These are the same estimates as those that have been published since 1997 and, therefore, do not represent any additional effects from this activity.

For these reasons NMFS has determined that the selection of the preferred "status-quo" alternative (Alternative 2) action will, by itself, neither significantly impact the fur seal stock, the overall quality of the human environment or cause any adverse impacts on any wildlife species listed under the ESA or MMPA.

The significant effect determination is not based on the direct or indirect effects of the alternatives. There is no indication that setting the subsistence harvest ranges consistent with previous years will have an adverse environmental effect. The significance determination is a cumulative effects determination based on the conditionally adverse effect of other activities, when considered with the alternatives proposed by this action.

(II) Direct Effects Taking into Account the Incremental or Cumulative Impacts of other Actions on Fur Seals and the Environment

Cumulative Effects from the Commercial Harvest of Fur Seals: The commercial harvest of fur seals was a major source of human-induced mortality for over 200 years, and the abundance of fur seals has fluctuated greatly in the past, largely due to this commercial harvest (NMFS 1993). Commercial harvest of fur seals peaked during 1961 with over 126,000 animals harvested, and the commercial harvest of fur seals ended in 1985 (NMFS 1993). Residual effects of past commercial harvests on the fur seal population are possible, but recent population declines have overshadowed any potential lingering residual effects. The northern fur seal was listed as a depleted stock under the Marine Mammal Protection Act (MMPA) in 1988. The reason for the designation was the steep decline in numbers (NMFS 1993). Therefore the harvest is historically significant but it is doubtful now whether the trends in fur seals can be attributed to the residual effects of the commercial harvest.

Cumulative Effects of Regime or Environmental Changes on Fur Seals: The present and predicted external effects of the environment on northern fur seals and their prey associated with climate change or regime shifts are likely based on the seals' wide distribution in the BSAI and EBS which would make them susceptible to large-scale regional changes in climate. Given recent declining trends in fur seal abundance and the unknown but likely relationship between these trends and environmental changes, these effects are considered conditionally adverse.

Cumulative Effects of Commercial Fishing on Northern Fur Seals:
The past external effects on northern fur seals due to incidental mortality in fisheries have been considerable and have contributed to population declines, especially from foreign fisheries. Present and predicted external effects include mortality sources while these animals are outside the EEZ and small levels of take in State-managed gillnet fisheries. Generally, however, the incidental take of northern fur seals at this time is uncommon in the groundfish fisheries. The last recorded mortality in any Alaskan groundfish fishery occurred in 1996, when the take rate was one animal per 1,862,573 mt of groundfish harvested. This level of take contributes little to the northern fur seal PBR of 18,244 (Ferrero *et al.,* 2000) and is inconsequential to population trends.

Entanglement in marine debris is more common in fur seals than any other species of marine mammal in Alaskan waters (Laist, 1987, 1997; Fowler, 1988). Mortality of northern fur seals from entanglement in marine debris contributed significantly declining trends in the Pribilof Islands during mid to late 1970s and early 1980s (Fowler, 1988). The contribution of the groundfish fishery is thought to be less than in previous years and, at this time, is considered insignificant (NMFS 2001).

The potential for disturbance effects caused by vessel traffic, fishing gear, or noise appears limited for northern fur seals. Interactions with other types of fishing gear, such as trawl nets, also appear limited based on the rare incidence of takes in groundfish fisheries. Disturbance effects on northern fur seal prey are difficult to identify Thus, a cumulative effect might be identified for disturbance but lacking information on the actual effect of disturbance, the cumulative effects was considered unknown

(III) Indirect Effects Taking into Account the Incremental or Cumulative Impacts of other Actions on Fur Seals and the Environment

The present and predicted external effects of the environment on northern fur seals and their prey associated with climate change or regime shifts are likely based on the seals' wide distribution in the eastern Pacific which would make the susceptible to large-scale regional changes in climate.

Given recent declining trends in fur seal abundance, these effects are considered conditionally adverse.

Since groundfish fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), competition due to the harvest rates of those species by commercial fisheries is said to have potential cumulative impacts based on the overlap between fisheries and fur seal foraging habitat and based on uncertainty as to the effect of harvest on fur seal populations. This cumulative effect is considered conditionally significant adverse (NMFS 2001). Further, given the uncertainty of the effect of increased fishing in fur seal habitat during June-August, the effects of fishing were rated as conditionally significant adverse.

Ecological interactions between northern fur seals and the groundfish fisheries are caused by the spatial and temporal overlap between fur seal foraging areas and groundfish fisheries and from competition for target and bycatch species.

Therefore, the cumulative effects on northern fur seals as a result of other activities, when considered with the alternatives proposed by this action, are significant and rated as conditionally adverse. These include the potential negative effects of the environmental shifts that might affect the availability of prey and the carrying capacity for fur seals, and the effects of commercial fishing on availability of fur seal prey based primarily on the overlap of the groundfish fisheries with fur seal foraging ranges, and on the lack of information from the groundfish fisheries that food availability is not related to recent population declines.

Areas of Controversy

The current subsistence harvest of northern fur seals on the Pribilof Islands is not considered controversial.

This Environmental Assessment results in a significant cumulative effects finding. Therefore, preparation of an environmental impact statement for the proposed action is required by NEPA regulations at Section 1501.4(c). The significant cumulative effects finding as a result of the potential negative effects of commercial fishing on availability of fur seal prey based primarily on the overlap of the groundfish fisheries with fur seal foraging ranges, and on the lack of information from the groundfish fisheries that food availability is not related to recent population declines, may be considered controversial.

Required Actions or Approvals

The preferred alternative will result in the authorization of an estimate (range) of northern fur seals that can be taken for subsistence purposes on St. Paul and St. George Islands, Pribilof Islands. No further actions or approvals are required for this action to go forward.

This Environmental Assessment results in a significant cumulative effects finding. Therefore, preparation of an environmental impact statement for the proposed action is required by NEPA regulations at Section 1501.4(c).

NEPA regulations at Section 1506.1 state that no action concerning this proposal can be taken that would have an adverse environmental impact or would limit the choice of reasonable alternatives until NMFS enters a Record of Decision. The preferred alternative in this assessment has neither an adverse environmental impact nor would it limit a range of reasonable alternatives during the development of, or prior to the completion of, the EIS required by this finding, NMFS, therefore, recommends that the preferred alternative (i.e, status-quo subsistence harvest) proceed as NMFS prepares an EIS and issues of Record of Decision. This recommendation is consistent with NEPA regulations at 40 CFR, Parts 1506.1.

The next NEPA procedure required of this process is for NMFS to publish a Notice of Intent (NOI) to conduct scoping. The NOI serves as the official legal notice that a Federal agency is commencing preparation of an EIS pursuant to 40 CFR 1501.7.

Chapter 1 Purpose and Need for Action

1.1 Purpose and Need

All federal actions must comply with applicable Federal laws and Executive Orders (E.O.s). The Federal laws most applicable to the management of marine mammals include: the Magnuson-Stevens Act, the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA) and the Regulatory Flexibility Act (RFA). The decision making process on this proposed action is informed by determining relative compliance of the various alternatives to federal laws and E.O.s.

Regulations at 50 CFR 216.72(b) require the Assistant Administrator for Fisheries (AA) to determine and publish the take ranges for the Pribilof Islands subsistence harvest of northern fur seals every three years. Therefore, this proposed action sets the annual Pribilof Islands fur seal subsistence take ranges for the period 2003-2005 as required by regulations. The subsistence harvest on each island is carefully monitored by onsite NMFS personnel to ensure that the harvest complies to the regulations. An annual report describing the conduct of the harvest is completed and submitted to the agency following each harvest season.

NMFS is required by NEPA and 40 CFR 1508.27 to consider the significance of the proposed action. The significance is determined by evaluating the context and intensity of the proposed action. The action being considered in this EA was analyzed as a whole, by effects on affected interests, and by short-and long-term effects. Additionally, the severity of the impacts were analyzed. The text summarizing this analysis of effects and cumulative effects of the proposed action with consideration to both context and intensity is found in Chapter 4. The Findings are found in Chapter 6.

1.2 Background

1.2.1 Commercial Harvest

The Pribilof Islands and its fur seal population were first discovered by Russian explorers in June 1786. From 1786 to 1828 the Russians, with Aleut labor, harvested an average 100,000 fur seals per year, primarily pups (Roppel, 1984). It was not until 1822 that bulls were protected and restrictions placed on the number of pups killed (Scheffer et al., 1984). From 1835 to 1839 an average of 70,000 seals were harvested annually. Beginning in 1847, the number of males taken was controlled and the harvest of females was stopped. About 30,000 to 35,000 fur seals were killed annually during the last 10 years of Russian occupation. The population was reportedly thriving and was sustaining an annual harvest of several thousand males when the United States purchased Alaska in 1867 (York and Hartley, 1981). During the first 2 years following the purchase of Alaska by the United States, the fur seal harvest ensued without regulations. For example, approximately 240,000 were taken in 1868 alone. Meanwhile, many fur seals were also harvested at sea (pelagic sealing).

The history of pelagic sealing (1875-1909), its impact on the fur seal population, and a subsequent treaty banning pelagic sealing is found in Roppel and Davey (1965). At the peak of pelagic sealing (1891-1900), more than 42,000 fur seals (mostly lactating females) were taken annually in the Bering Sea (Scheffer et al., 1984). In addition, pelagic sealing was removing a large but unknown number of fur seals from waters off British Columbia (Scheffer et al., 1984). Because the takes were greatly reducing the fur seal stock, Great Britain (for Canada), Japan, Russia, and the United States ratified the Treaty for the Preservation and Protection of Fur Seals and Sea Otters in 1911. The treaty prohibited pelagic sealing and required a reduction in the taking of seals on the land. The population grew rapidly after the cessation of pelagic sealing until the mid 1940s. There was no commercial harvest from 1912-1917. From 1918 to about 1941, the Pribilof Island fur seal stock grew at 8 percent per year under a harvest which ranged from 15,862 in 1923 to 95,016 in 1941. In 1941, Japan abrogated the 1911 Convention on the grounds that fur seals were too numerous and were damaging her fisheries; after World War II, a similar concern on the part of Japan was important in negotiating the 1957 fur seal Convention (Scheffer, 1980). No commercial harvest took place in 1942. The take from 1943 to 1955 averaged about 70,000 per year.

In 1957, the signatories of the 1911 Treaty ratified a new agreement, the Interim Convention on the Conservation of North Pacific Fur Seals, for the conservation, research, and harvesting of fur seals. During those negotiations, calculations presented by the United States suggested that maximum sustained productivity would occur at lower female population levels than those of the early 1950s. These projections postulated higher pregnancy and survival rates from a smaller herd (Anonymous, 1955). Consistent with that analysis, from 1956 to 1968, a total of about 300,000 female fur seals were killed on the Pribilof Islands (York and Hartley, 1981). Concurrently, 30,000 to 96,000 juvenile males were harvested each year (Lander and Kajimura, 1982), and a pelagic collection of about 16,000 females was taken for research purposes by the United States and Canada during 1958-1974 (York and Hartley, 1981).

The Pribilof Islands fur seal population did not react as expected to the herd reduction program. Kajimura et al. (1979) showed neither a substantial decrease in age at first pregnancy nor an increase in pregnancy rates as the population was reduced. Also, increased survival rates did not overcome losses to the population resulting from intentional herd reduction. These changes generated speculation that some natural factor or combination of factors had prohibited the expected recovery of the herd. Clearly, one or more factors, whether natural or man-made, adversely affected the recovery of the herd and caused extreme fluctuations in year class survival and a much reduced production of young males (Roppel, 1984). The United States believed it necessary to establish a research control area because of the failure of the Pribilof Islands population to respond as anticipated to changes in the management scheme started in 1956. Therefore, in 1973, a moratorium on the commercial harvest of male fur seals was established at St. George Island (Roppel, 1984), while the commercial harvest on St. Paul Island continued. Thus, the first long-term study of behavior in the history of fur seals on the Pribilof Islands began in 1973 (Roppel, 1984). Meanwhile, on St. Paul Island, management regulations changed very little between 1973-1979, and harvests ranged from 24,000 to 27,000 animals per year (Harry and Hartley, 1981).

The authority of the 1957 Convention was extended in 1963, 1969, 1976 and 1980. Under the terms of the 1980 extension, the Convention expired on 14 October 1984. In consultation with the U.S. Departments of State and Justice, and the Marine Mammal Commission, the United States declined to sign an extension. It was determined that no commercial harvest could be conducted under existing domestic law and, therefore, the commercial harvest on St. Paul Island was terminated. Management of the fur seal then reverted to the MMPA.

1.2.2 Subsistence Harvest

Following the termination of the commercial harvest, NMFS issued an emergency interim rule on July 8, 1985, to govern the subsistence taking of fur seals for the 1985 season under the authority of section 105(a) of the Fur Seal Act. A final rule was published on July 9, 1985. The subsistence harvest of northern fur seals on the Pribilof Islands, Alaska, is governed by regulations found in 50 CFR part 215 subpart D--Taking for Subsistence Purposes. These regulations were published under the authority of the Fur Seal Act, 15 U .S.C. 1151, and the MMPA, 16 U.S.C. 1361 (see 51 FR 24828, July 9, 1986). The purpose of these regulations was to limit the take of fur seals to a level providing for the subsistence needs of the Pribilof Aleuts using humane harvesting methods, and to restrict taking by sex, age, and season for herd management purposes.

NMFS publishes a proposed annual subsistence harvest estimate. The purpose of the notice is to provide an estimate for the annual subsistence need for St. Paul and St. George Islands. To minimize negative effects on the population, the subsistence harvest has been limited to a 47-day harvest season (June 23-August 8) during which only sub adult male seals may be taken. In early August, immature female seals begin arriving at the rookeries in large numbers, and the immature females and males, which are not easily distinguished, become intermixed. The August 8 deadline was chosen to avoid an unacceptable taking of female fur seals.

The AA is required to terminate the harvest when it is determined that the subsistence needs of the Pribilof Aleuts have been met or on August 8 of each year, whichever comes first. From 1985 to 1992, the regulations allowed for extending the harvest period if the subsistence need of the Pribilof Aleuts have not been met. Section 215.32(t)(2) authorized the AA to extend the harvest period until September 30 if, by August 8, the subsistence needs of the Pribilof Aleuts were not met, and the number of female seals taken during the harvest was low. In 1986 and 1987 extensions to the harvest season were requested and granted. However, the extensions of the harvest beyond the first week of August resulted in an increased number of female fur seals taken. In response, NMFS announced its intent to amend 50 CFR 215.32(t) to eliminate the extension option for 1989 and subsequent years (53 FR 28887, Aug. 1, 1988), although no further action was taken by NMFS at that time. Extensions have been requested and granted since that date without complications in the harvest.

Following the August 1, 1988, notice by NMFS, the Aleut Community of St. Paul Island requested a change in the Fur Seal Act regulations to allow the subsistence harvest to begin June 23, 1 week earlier than the June 30 start date dictated by 50 CRF 215.32(c)(I). They cited a desire for seal meat by community members before June 30, a lack of meat remaining from the previous year's take, and the possible inability to harvest their quota of seals in the absence of the harvest extension option. On June 3, 1991, NMFS published a proposed rule to eliminate the extension option and to begin the harvest 1 week earlier (56 FR 25066). The final rule was published on July 31, 1992 (57 FR 33900).

Prior to the 1994 subsistence harvest, NMFS, in cooperation with the tribal governments of each island, conducted an annual household survey of the local subsistence communities to estimate the number of seals required to meet their subsistence needs for that year. NMFS would then publish the proposed estimates in the FR for comment prior to finalizing the number of seals that could be taken on each island. These estimates were set for each island and consisted of a lower and upper range.

On May 13,1994, NMFS published a proposed rule to change the manner in which the harvest take ranges were established by setting the ranges for a 3 year period rather than annually. The reason for this change was that the annual household survey of subsistence needs regarding fur seals was time consuming, regarded as intrusive by some local residents, and since the number of seals taken for subsistence purposes had been relatively stable and consistent each year since 1989, it was determined that setting the ranges for a 3 year period would be as satisfactory an approach as the annual process. A final rule was published on July 12, 1994 (59 FR 35471) setting the ranges for the period 1994-1997 at the same levels as had been established for the 1992 and 1993 harvests.

In September 1996, NMFS requested that the Tribal Government of each island determine the number of fur seals that would be needed by their communities each year for the 3-year period 1997 through 1999. The response from the St. Paul Island Tribal Government was to maintain the current range of 1,645-2,000 seals. The St. George Island tribal government requested that the lower end range be increased from 281 to 300 seals and that the upper bound remain at 500 seals. The approach was repeated for the period 2000-2002 and the same harvest ranges were established (final rule published on June 21, 2001). This proposed rule will establish those ranges for the period 2003-2005.

1.3 Related NEPA Documents

On April 2, 1985, NMFS published a final environmental impact statement (EIS) on the future of the Interim Convention on Conservation of Northern Fur Seals which contained a discussion of four alternatives including allowing the Convention to expire which finally became the preferred alternative. This alternative contained a discussion of the consequences of a subsistence harvest on the Pribilof Islands.

On May 12, 1986, NMFS published an environmental assessment on the first regulations governing the subsistence taking of northern fur seals. This EA tiered down from the analyses contained in the 1985 EIS and concluded that the action would not have a significant affect on the human environment other than those described in the April 1985 Final EIS on the Interim Convention. Therefore, an EIS was not prepared for the subsistence harvest regulations.

The alternatives considered under the 1986 EA were to regulate the subsistence harvest through Federal regulations (preferred alternative); and to allow unregulated taking of fur seals for subsistence purposes (no action alternative). A Finding of No Significant Impact (FONSI) was published on May 12, 1986.

On June 21, 2001, NMFS made an EA available through Federal Register notice concurrent to publishing the final estimates of fur seal subsistence needs through 2002. The EA examined two alternatives; setting the take ranges at levels other than those first established in 1997; and setting the levels at those agreed upon and that have occurred since 1997 (status quo Alternative 1 (this EA) is consistent with harvest levels that are in effect at this time).

1.4 Related and Other Applicable Actions taken that Affect the Subsistence Harvest of Fur Seals on the Pribilof Islands.

NMFS has entered into co-management agreements with the Tribal Governments of St. Paul Island and St. George Island under section 119 of the MMPA in 2000 and 2001, respectively. These agreements are specific to the conservation and management of northern fur seals and Steller sea lions on the Pribilof Islands, with particular attention to the subsistence take and use of these animals. NMFS has worked with both communities to integrate the agreements into one management plan for the purpose of recovering and maintaining sea lion and fur seal populations to levels which provide for a sustainable subsistence take of these species in the Pribilof Islands region.

In conjunction with the implementation of the co-management plans, AKR is working with both Tribal Governments on the Pribilof Islands to revise and update the 1993 Conservation Plan for Northern Fur Seals to reflect the co-management approach to protection, conservation and management of this population. Contracts have been developed with the Tribal Governments to facilitate their role in the development of the Conservation Plan.

.

Under each of the agreements a co-management committee was formed to review, among other things, the manner in which the subsistence harvest in prosecuted and managed, and regulations governing the subsistence harvest of fur seals. These committees have begun to review the consequences of changing the current regulations governing the harvest in ways that would be considered significant in context (such as removing current regulations and managing the subsisence harvest under section 119 of the MMPA). However, at this time neither the Tribal Governments nor NMFS are in a position to recommend changes to the status quo management of northern fur seals.

1.5 Coordination with Others and Public Participation

The Council on Environmental Quality (CEQ) Regulations for implementing the procedural provisions of NEPA emphasize agency cooperation early in the NEPA process. Section 1501.6 states: “Upon request of the lead agency, any other Federal agency which has jurisdiction by law to be a cooperating agency. In addition, any other Federal agency which has special expertise with respect to any environmental issue, which should be addressed in the statement, may be a cooperating agency.” (40 CFR 1501.6) . The appropriate “agencies” for this action include both Tribal Governments.

This analysis was developed and alternatives presented with full anticipation of, and opportunity for, public participation in the development of the final estimates by the Tribal Governments of St. Paul and St. George, and the general public. NMFS received letters from each of the Tribal Government of St. Paul Island and St. George Island on October 21, 2002, and November 5, 2002, respectively. Both letters addressed the appropriate take ranges for this proposed action, and the appropriate NEPA analysis for the action being considered (EIS vs. EA). Both Tribal Governments indicated that the action has not changed and the effects analysis should be consistent with previous NEPA reviews. They recommended that establishing the take ranges for 2003-2005 was, itself, not a significant action under NEPA and an EA was the appropriate level of review.

Further, the development of the EIS as required by the findings of this EA will involve a much expanded scoping process, public involvement, and require working within the Pribilof Islands Ecosystem Stakeholder Process, a committee of constituents interested in the broader management of the Pribilof Islands ecosystem of which the fur seal stock , environmental concerns and commercial fishing are major components.

1.6 Federal Trust Responsibilities

The concept of 'trust responsibility" is derived from the relationship between the Federal government and Indians, first delineated by Supreme Court Justice John Marshall in 1831. The scope of the Federal trust relationship is broad and incumbent upon all Federal agencies. The U.S. Government has an obligation to protect tribal land, assets, and resources as well as a duty to carry out the mandates of Federal law with respect to American Indian and Alaska Native tribes. The unique relationship provides the Constitutional basis for legislation, treaties, and Executive Orders that grant unique rights or privileges to Native Americans.

Executive Order (E.O.) 13084 issued May 14, 1998, requires each Federal agency to establish meaningful consultation and collaboration with Indian tribal governments (including Alaska Natives) in formulating policies that significantly or uniquely affect their communities. Entitled "Consulation and Coordination with Indian Tribal Governments", the order requires agency policy making to be guided by principles of respect for tribal treaty rights and responsibilities that arise from the unique legal relationship between the Federal Government and the Indian trial governments. Furthermore on issues relating to treaty rights, E.O .13084 directs each agency to explore, and , where appropriate, use consensual mechanisms for developing regulations.

On November 6, 2000, E.O. 13175 replaced E.O. 13084. The order carries the same title and strengths as the previous order about the government-to-government relationship between the U.S. Government and Indian tribes. E.O. 13175 requires that all Executive departments and agencies consult with Indian tribes and respect tribal sovereignty as they develop policy on issues that impact Indian communities.

1.6.1 Other Federal Mandates

The Environmental Protection Agency (EPA) is a reviewing agency for all EISs.

1.7 Action Area

The subject action occurs in the Bering Sea, on the Pribilof Islands of St. Paul and St. George.

1.8 Required Actions or Approvals

The preferred alternative will result in the authorization of an estimate (range) of northern fur seals that can be taken for subsistence purposes on St. Paul and St. George Islands, Pribilof Islands. No further actions or approvals are required for this action to go forward.

This Environmental Assessment results in a significant cumulative effects finding. Therefore, preparation of an environmental impact statement for the proposed action is required by NEPA regulations at Section 1501.4(c).

NEPA regulations at Section 1506.1 state that no action concerning this proposal can be taken which would have an adverse environmental impact or would limit the choice of reasonable alternatives until NMFS issues a record of decision. The preferred alternative in this assessment would neither have an adverse environmental impact nor would it limit a range of reasonable alternatives during the development of, or prior to the completion of, the EIS required by this finding, NMFS, therefore, recommends that the preferred alternative (i.e, status-quo subsistence harvest) be allowed to proceed simultaneously with the completion of the required EIS. The EIS must be completed prior to the promulgation of any further regulations regarding fur seals. This recommendation is consistent with NEPA regulations at 40 CFR, Parts 1506.1.

The next NEPA procedure required of this process is for NMFS to publish a Notice of Intent (NOI) to conduct scoping. The NOI serves as the official legal notice that a Federal agency is commencing preparation of an EIS pursuant to 40 CFR 1501.7.

Chapter 2 Alternatives Considered

2.1 NEPA Guidance for Alternatives

The CEQ regulations for implementing the procedural provisions of NEPA require consideration of several alternatives, or a range of alternatives, to be evaluated in addition to the proposed action, and the environmental impacts of activities (in this instance, fish harvest) under each of these management alternatives to be evaluated. Two alternatives are presented for analytical purposes. These can be evaluated from information and analysis provided in Chapter 3 (Affected Environment) and Chapter 4 (Environmental Consequences). This information presents the issues and impacts, thus providing the basis for choice among alternatives by the agency and the public.

2.2 Description of Proposed Alternatives

The following two alternatives have been identified regarding this action:

Alternative 1: Propose that the annual take ranges for the subsistence harvest of northern fur seals on the Pribilof Islands be set at the same levels as those established in 1997 (status quo). This is the Preferred Alternative by NMFS and the alternative recommended by the Tribal Governments at this time.

Alternative 2: Propose that the annual take ranges for the subsistence harvest of northern fur seals on the Pribilof Islands be set at levels different from, either greater or lesser than, those established in 1997 and 2000.

2.2.1 Alternative 1 - Status Quo

This alternative continues the harvest under an established process to establish harvest take levels, and a set of agreed upon take levels, that have been in place since 1997. It also supports the co-management relationship between NMFS and the local tribal governments regarding the management and conduct of the subsistence harvest of fur seals on the Pribilof Islands. Based on historic take levels, current scientific data and collective traditional knowledge regarding subsistence needs of the respective communities, take ranges have been established that are cooperatively determined by NMFS and local tribal governments.

This approach is fully supported by the long history of federal trust involvement on the Pribilof Islands regarding northern fur seals and the Aleut communities. This alternative is considered to be the most appropriate and therefore, is preferred and recommended for approval.

This alternative is consistent with the current practice of establishing the take ranges for the subsistence harvest.

2.2.2 Alternative 2: Setting the Take Ranges at Levels Other Than Those Established in 1997

NMFS has a long and very involved history regarding the Aleut residents of the Pribilof Islands and the northern fur seal stock, including recent implementation of the co-management process with the respective local tribal governments of the Islands. This history clearly establishes a unique relationship between the local communities of the Pribilof Islands and NMFS. Since the termination of the commercial fur seal harvest there has been established a cooperative working relationship between the Aleuts and NMFS which has resulted in effective management of the subsistence harvest of fur seals on the Pribilof Islands. Among those refinements have been a more stable and consistent level of take and increased utilization of harvested seals.

Setting subsistence take ranges, either greater or lesser, than those established in 1997 would require that NMFS make a unilateral determination as to the estimated subsistence needs of the Pribilof Island communities of St. Paul and St. George. This determination would be independent from, and contrary to, the levels agreed upon as a result of numerous discussions and negotiations with the tribal governments who represent the collective interests of the tribal residents of those communities. Therefore, NMFS would need a rationale management or scientific basis to make such a unilateral determination

.
Further, pursuing this alternative without any documented indication of adverse effects of the subsistence harvest on the northern fur seal might be considered contrary to the co-management policy established by section 119 of the MMPA. Under this policy NMFS can establish cooperative agreements with Alaska Native Organizations (ANO's), including tribal governments regarding the uses of marine mammals taken by Alaskan Natives for subsistence purposes.

Given that NMFS has no information or data indicating that the subsistence harvest of fur seals on the Pribilof Islands is having any significant impact or adverse consequence to the northern fur seal stock, and the inconsistencies with section 119 of the MMPA if a unilateral decision were made by either NMFS or it's co-management partner, this alternative was not selected as the preferred alternative.

2.3 Alternatives Considered but Rejected

During the development of this EA only the no-action alternative was considered and rejected at this time. Other alternatives for harvest management are being considered for further NEPA analysis. At this time neither NMFS nor the Tribal Governments were prepared to recommend any other alternatives than those considered in section 2.2 and the "no-action" alternative.

2.3.1 No-action Alternative

Regulations at 50 CFR 216.72(b) require the AA to determine and publish the take ranges for the Pribilof Islands subsistence harvest of northern fur seals every three years. Therefore, the "No Action" alternative was not considered by NMFS.

Chapter 3 Affected Environment

The purpose of this chapter is to describe the environment of the Bering Sea and Aleutian Islands (BSAI) including the Pribilof Islands. The descriptions focus on physical and oceanographic features, major living marine resources—their biology, habitat, and current status of the resource—with special emphasis on the fur seal resource. This chapter provides an overview of the environment with references to scientific literature cited throughout the text.

3.1 The Bering Sea Ecosystem

Two large marine ecosystems have been identified off Alaska, the eastern Bering Sea/Aleutian Islands (BSAI) and the Gulf of Alaska (GOA). Their continental shelf areas make up about 74 percent of the total area (2,900,785 square kilometers [km^2]) of U.S. continental shelves. This assessment will focus on the BSAI, the Eastern Bering Sea (EBS) and Pribilof Islands.

The Bering Sea is a semi-enclosed, high-latitude sea. Of its total area of 2.3 million km^2, 44 percent is continental shelf, 13 percent is continental slope, and 43 percent is deep water basin. Its broad continental shelf is one of the most biologically productive areas of the world. A special feature of the Bering Sea is the pack ice that covers most of its eastern and northern continental shelf during winter and spring. The dominant circulation of the water begins with the passage of North Pacific water (the Alaskan Stream) into the Bering Sea through the major passes in the Aleutian Islands (Favorite et al. 1976). There is net water transport eastward along the north side of the Aleutian Islands, and a turn northward at the continental shelf break and at the eastern perimeter of Bristol Bay. Eventually Bering Sea water exits northward through the Bering Strait, or westward and south along the Russian coast, entering the western North Pacific via the Kamchatka Strait. Some resident water joins new North Pacific water entering Near Strait, which sustains a permanent gyre around the deep basin in the central Bering Sea.

3.1.1 Substrate

The EBS sediments are a mixture of the major grades representing the full range of potential grain sizes of mud (subgrades clay and silt), sand, and gravel. Relative composition by such constituents determines the type of sediment at any one location. Overall, there is often a tendency of the fraction of finer-grade sediments to increase (and average grain size to decrease) with increasing depth and distance from shore (Smith and McConnaughey 1999).

Considerable local variability is indicated in areas along the shores of Bristol Bay and the north coast of the Alaskan Peninsula, as well as west and north of Bristol Bay, especially near the Pribilof Islands. Nonetheless, there is a general pattern whereby nearshore sediments in the east and southeast on the inner shelf (0–50 m depth) often are sandy gravel and gravelly sand. These give way to plain sand farther offshore and west. On the middle shelf (50–100 m), sand gives way to muddy sand and sandy mud, which continue over much of the outer shelf (100–200 m) to the start of the continental slope.

3.1.2 Water Column

Important water column properties over the EBS include temperature, salinity, and density. These properties remain constant with depth in the near-surface mixed-layer, which varies from about

10–30 m in summer to about 30–60 m in winter (Reed 1984). The inner shelf (less than 50 m) is, therefore, one layer and well-mixed most of the time. On the middle shelf (50–100 m), a two-layer temperature and salinity structure exists because of downward mixing of wind and upward mixing due to relatively strong tidal currents (Kinder and Schumacher 1981). On the outer shelf (100–200 m), a three-layer temperature and salinity structure exists due to downward mixing by wind, horizontal mixing with oceanic water, and upward mixing from the bottom friction due to relatively strong tidal currents. Oceanic water structure is present year-round beyond the 200-m isobath.

Overall, surface temperatures in winter vary from about -1°C in the north to about 3°C in the south, then increase to a maximum in August of 8°–12°C, with the higher temperatures near shore. On the well-mixed inner shelf, temperatures are isothermal and vary with the annual cycle. On the middle shelf, surface temperatures warm with the season, but the lower layer remains less than 2°C year-round. The temperature changes on the outer shelf show the seasonal mixed layer above but stay about 3°–4°C year-round in the two lower layers due to oceanic influences and warm advection from the south.

Surface salinities range from about 31.4 psu inshore to about 32.4 psu on the outer shelf to about 33.1 psu in the oceanic water. Lower salinities may be found close inshore near river mouths, and the patterns of the isohalines show low-salinity water from the GOA entering the Bering Sea at Unimak Pass and proceeding along the north side of the Alaska Peninsula to Bristol Bay (Royer 1981, Schumacher et al. 1982). The bottom salinities on the inner shelf also show this low-salinity feature north of the Alaska Peninsula. Bottom salinities over the entire shelf range typically from 31.4 to 32.8 psu, slightly higher than at the surface. The highest bottom salinities are present west of Unimak Pass in summer, possibly from enhanced inflow of oceanic water to the inner slope.

3.1.3 Temperature and Nutrient Regimes

Three fronts, the outershelf, mid-shelf, and innershelf, follow along the 200-, 100-, and 50-m bathymetric contours, respectively; thus, separate four oceanographic domains appear as bands along the broad EBS shelf. The oceanographic domains are the deep water (over 200 m), the outer-shelf (200–100 m), the mid-shelf (100–50 m), and the innershelf (under 50 m). Water structure and properties are described by Reed (1995); Hattori and Goering (1986) summarize the available data on the distribution of salinity, temperature, phosphate-phosphorus, silicic acid, nitrate-nitrogen, nitrite-nitrogen, and ammonia-nitrogen (Table 3.1) and characterize the four domains according to nutrients. Inorganic nutrient nitrogen distribution and dynamics were also described by Whitledge et al. (1986). Because the fronts inhibit lateral fluxes of water and dissolved materials between the four domains, nutrient zones are consistent with the physical domains.

The vertical physical system also regulates the biological processes that lead to separate cycles of nutrient regeneration. The source of nutrients for the outershelf is the deep oceanic water and for the mid-shelf, it is the shelf-bottom water. Starting in winter, surface waters across the shelf are high in nutrients. Spring surface heating stabilizes the water column, then the spring bloom commences and consumes the nutrients. Steep seasonal thermoclines over the deep Bering Sea (30–50 m), the outershelf (20–50 m), and the mid-shelf (10–50 m) restrict vertical mixing of water between the upper and lower layers. Below these seasonal thermoclines nutrient concentrations in the outer-shelf water are invariably higher than those in the deep Bering Sea water with the same salinity. Winter values for nitrate-N/phosphate-P are similar to the summer ratios which suggests that even in winter the mixing of water between the mid-shelf and outer-shelf domains is substantially restricted (Hattori and Goering 1986).

Table 3.1 Characteristics of Four Oceanographic Domains of the Eastern Bering Sea Shelf in Summer, 1978

	Deep Bering Sea	Outershelf	Mid-Shelf	Coastal
Salinity (psu)	32.66–33.35	32.45–33.03	31.53–31.91	29.18–31.09
Temperature (°C)	2.85–8.50	2.88–8.60	-0.13–7.80	4.72–11.0
Phosphate (µg at/l)	0.82–2.57	0.46–2.22	0.11–1.72	0.10–0.29
Nitrate (µg at/l)	2.5–32.2	0.05–28.4	0.0–8.9	0.0–0.07
Silicic acid (µg at/l)	11.0–83.7	5.2–69.0	5.6–36.2	3.2–24.4

Source: Hattori and Goering 1986

Spring and summer storms can increase the total seasonal productivity by mixing to depths sufficient to resupply nutrients to the euphotic zone, but by the end of summer, nutrient depletion in the euphotic zone is common all across the shelf. Year-to-year consistency of trends between summer nutrient distributions in 1975 and 1978 was shown by Hattori (1979).

3.1.4 Currents

The GOA and Aleutian Islands compose the eastern and northern boundaries of the main counterclockwise gyral circulation of the subarctic Pacific region. The smaller counterclockwise gyral circulation in the Bering Sea is a northern offshoot from the western part of the region. Figure 3.1-4 (frm NMFS 2001) shows the climatological mean circulation patterns of the subarctic Pacific region based on geostrophic flow, and direct current measurements (Schumacher and Kendall 1995, Schumacher and Stabeno 1998). Mixing upward from the bottom due to tidal currents may be important on many time scales due to the recirculating of nutrients important for maintaining standing stocks of lower trophic levels, which feed the higher trophic levels of the ecosystem (Parker et al. 1995).

3.1.5 Sea Ice

Oceanic conditions in the Bering Sea are influenced by the extent of ice cover (Figure 3.1-5, from NMFS 2001). During extreme conditions, ice covers the entire eastern shelf; however, interannual variability of coverage can be as great as 40 percent (Niebauer 1988). The buoyancy flux from melting ice initiates both baroclinic transport along the marginal ice zone (approximately 0.3×10^6 m^3 s^{-1}) (Muench and Schumacher 1985) and stratification. The ensuing ice edge bloom of phytoplankton accounts for between 10 percent and 65 percent of the total annual primary production (Niebauer et al. 1990). The nutrient-rich slope waters combine with summer solar radiation to create one of the world's most productive ecosystems (Walsh et al. 1989).

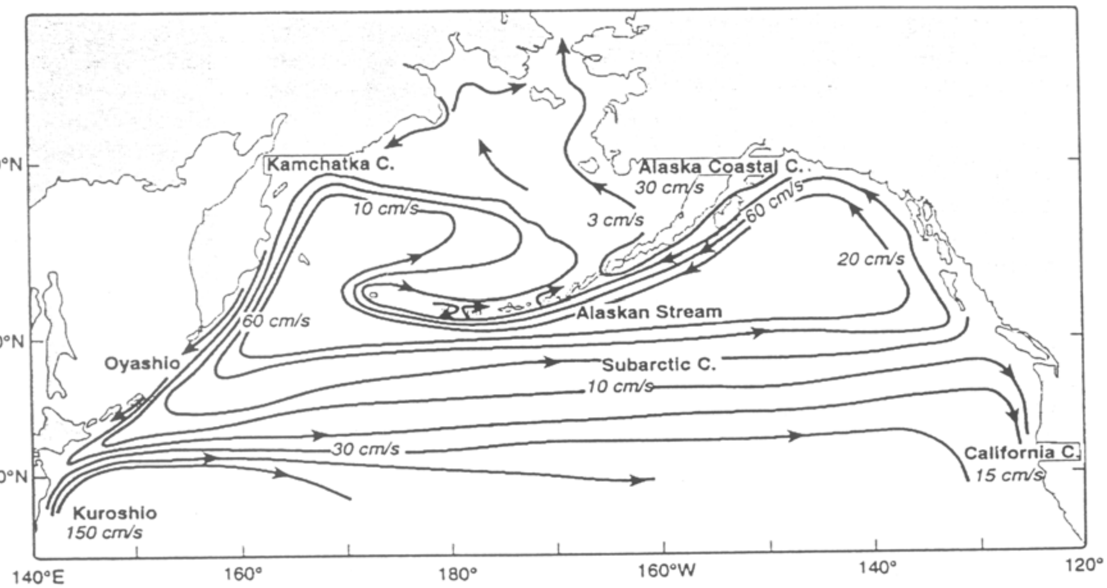


Figure 3.1-4 Estimates of climatological mean surface circulation in the subarctic Pacific Ocean. Source: Reed and Schumacher 1986.

3.1.6 Trophic Relationships in the BSAI

3.1.6.1 Environmental Regime Shifts

The BSAI lies on the northern edge of a larger regime north of about 42°N called the subarctic Pacific region. Physical features in this regime are primarily driven by the winter atmospheric circulation, in particular the Aleutian low which nearly covers this entire regime. Year-to-year, decadal, and longer term changes in the shape of the Aleutian low determine the nature of the regime.

Regime shifts imply shifts in a characteristic behavior of a natural phenomenon, such as the major spatial and temporal features in the distributions of sea level pressure, wind, sea surface temperature, ice, or ocean currents. To give the best assessment of recent regime shifts in the BSAI, Minobe (1997 and 1999) studied changes in the Aleutian low over the last century and Hare and Mantua (2000) studied changes in the eastern North Pacific from 1965–1997.

3.1.6.2 Bering Sea and Aleutian Islands Regime Changes

The regime shift of 1976/1977 is now widely recognized, as well as its associated far-reaching

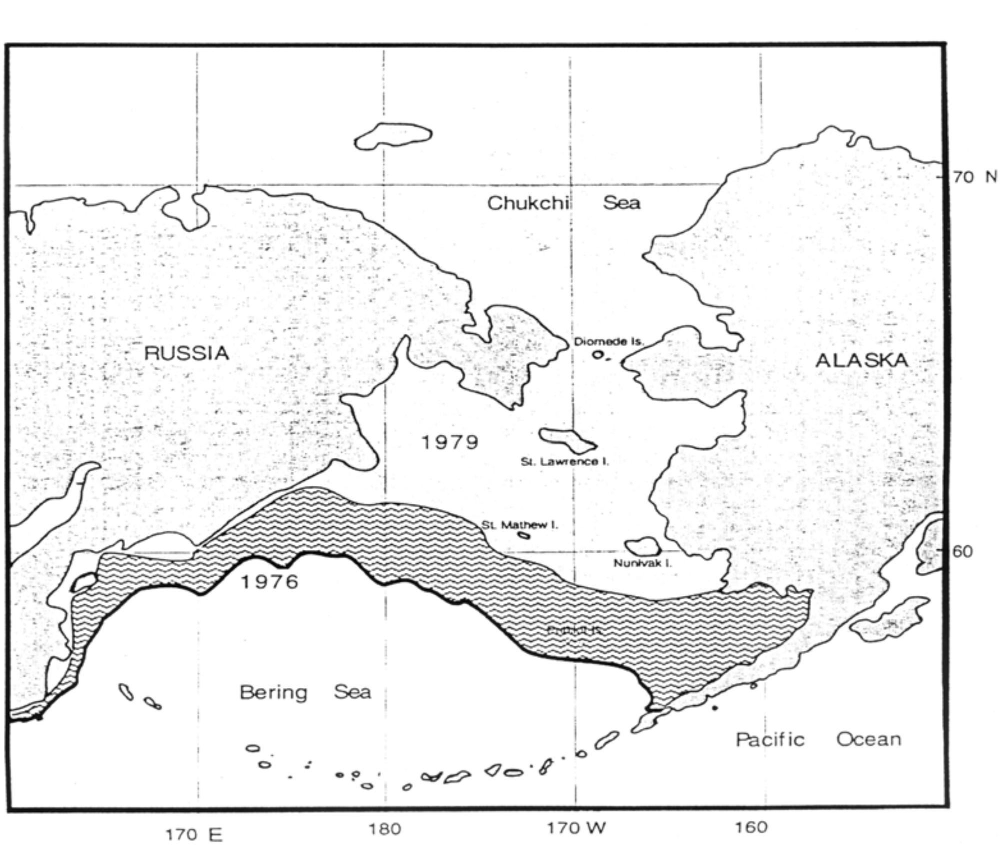


Figure 3.1-5 Maximum (1976) and minimum (1979) extent of sea ice in the Bering Sea in recent years. Source: NMFS

consequences for the large marine ecosystems of the North Pacific Ocean. The most recent regime shift (1989) has been studied indepth by Hare and Mantua (2000), who assembled and examined 100 environmental time series of indices (31 climatic and 69 biological) as evidence of regime shift signals. A few of these examples are presented to illustrate that such signals are evident in the BSAI and GOA data.

Evidence from sea surface temperature anomalies around the Pribilof Islands indicate that the BSAI environmental regime appears to have shifted. (Figure 3.1-7[(a], from NMFS 2001). The dominance of positive (warm) anomalies from 1977 to 1988 switched rapidly to negative (cold) anomalies in 1989, which were still dominating as late as 1997. Further evidence of a shift is seen in the time series of the southern extent of sea ice along 167°W, but the shift is less pronounced and more of a broad trend to cooler conditions with more ice.

A particularly striking example of biological changes was from a time series of quantitative catches of large medusae from bottom trawl surveys on the EBS shelf from 1979 to 1997 (Brodeur et al. 1999). The dramatic increase was in the 1990s, when the median biomass increased tenfold between the 1982–1989 and 1990–1997 periods. Several large-scale, winter–spring atmospheric and oceanographic variables in the Bering Sea also changed around 1990.

3.1.6.3 Distant Forcing Parameters that Influence the Area

Decadal and basin-scale climate variability can impact fish production and ecosystem dynamics. Sudden basinwide shifts in climate regime have been observed in the North Pacific Ocean (Mantua et al. 1997). These shifts appear to result from changes in atmospheric forcing. A climatology of the wind forcing shows that eastward- and northward-propagating storm systems dominate the surface wind stress at short periods (less than one month), which serves principally to mix the upper ocean (Bond et al. 1994).

A large-scale shift in atmospheric forcing occurred in the late 1970s. North Pacific winter sea level pressure in the area averaged between 30°N and 65°N and 160°E and 140°W showed a mean pressure of about 1,010 mb from 1946 to 1977, changing to about 1,007 mb from 1977 to 1988 when it changed back to about 1,010 mb (Trenberth and Hurrell 1994). The timing of blocking marine ridges has changed from being primarily in winter in the early 1970s to primarily in fall in the late 1970s (Salmon 1992). Ingraham and Ebbesmeyer (Ingraham et al. 1998) used the Ocean Surface Current Simulations (OSCURS) model to generate wind driven surface drift trajectories initiated during winter months (December–February) for the period 1946 to present. The endpoints of these three-month drift trajectories shifted in a bimodal pattern to the north and south around the mean. The winter flow during each year is persistent enough to result in a large displacement of surface mixed-layer water. The displacement also varies in a decadal pattern. Using the rule that the present mode is maintained until three concurrent years of the opposite mode occur, four mode shifts were suggested: a south mode from 1946 to 1956, a north mode from 1957 to 1963, a south mode from 1964 to 1974, and a north mode from 1975 to 1994.

Atmospheric forcing impacts sea surface temperatures. Two principal modes of remotely forced sea surface temperature anomalies include shorter term El Niño/Southern Oscillation (ENSO) events and longer term Pacific Decadal Oscillations (Mantua et al. 1997). Temperature anomalies in the Bering Sea illustrates a relatively warm period in the late 1950s, followed by cooling (especially in the early 1970s), followed by a rapid temperature increase in the latter part of that decade. Since 1983, the Bering Sea have undergone different temperature changes: the sea surface temperatures in the Bering Sea were below normal. The temperature differences between the two bodies of water have jumped from about 1.1°C to about 1.9°C (GLOBEC 1996). Subsurface temperature anomalies for the coastal GOA also show a change from the early 1970s into the 1980s similar to that observed in the sea surface (U.S. GLOBEC 1996). In addition, high latitude temperature responses to ENSO events can be seen, especially at depth, in 1977, 1982, 1983, 1987, and in the 1990s. The 1997–1998 ENSO event, one of the strongest recorded this century, has significantly changed the distribution of fish stocks off California, Oregon, Washington, and Alaska. The longer-term impacts of this event remain to be seen.

Francis et al. (1998) reviewed the impacts of the most recent regime shift through lower, secondary, and top trophic levels of the North Pacific Ocean marine ecosystem. Some of the following impacts on higher trophic levels are based on this review:

- Parker et al. (1995) show marked similarities between time series of the lunar nodal tidal cycle, and recruitment patterns of Pacific halibut.

- Hollowed and Wooster (1995) examined time series of marine fish recruitment and observed that some marine fish stocks exhibited an apparent preference (measured by the probability of strong year and average production of recruits during the period) for a given climatic regime.

- Hare and Francis (1995) found a striking similarity between large-scale atmospheric conditions and salmon production in Alaska.

- Quinn and Niebauer (1995) studied the Bering Sea pollock population and found that high recruitment coincided with years of warm ocean conditions (above normal air and bottom temperatures and reduced ice cover). This fit was improved by accounting for density dependent processes.

Piatt and Anderson (1996) provide evidence of possible changes in prey abundance due to decadal scale climate shifts. These authors examined relationships between significant declines in marine birds during the past 20 years and found significant declines in common murre populations occurred from the mid to late 1970s to the early 1990s. Piatt and Anderson (1996) found marked changes in diet composition of five seabird species collected in the GOA from 1975 to 1978 and from 1988 to 1991, from a capelin-dominated diet in the late 1970s to a diet in which capelin was virtually absent in the later period.

On a larger scale, evidence of biological responses to decadal-scale climate changes are also found in the coincidence of global fishery expansions or collapses of similar species complexes.

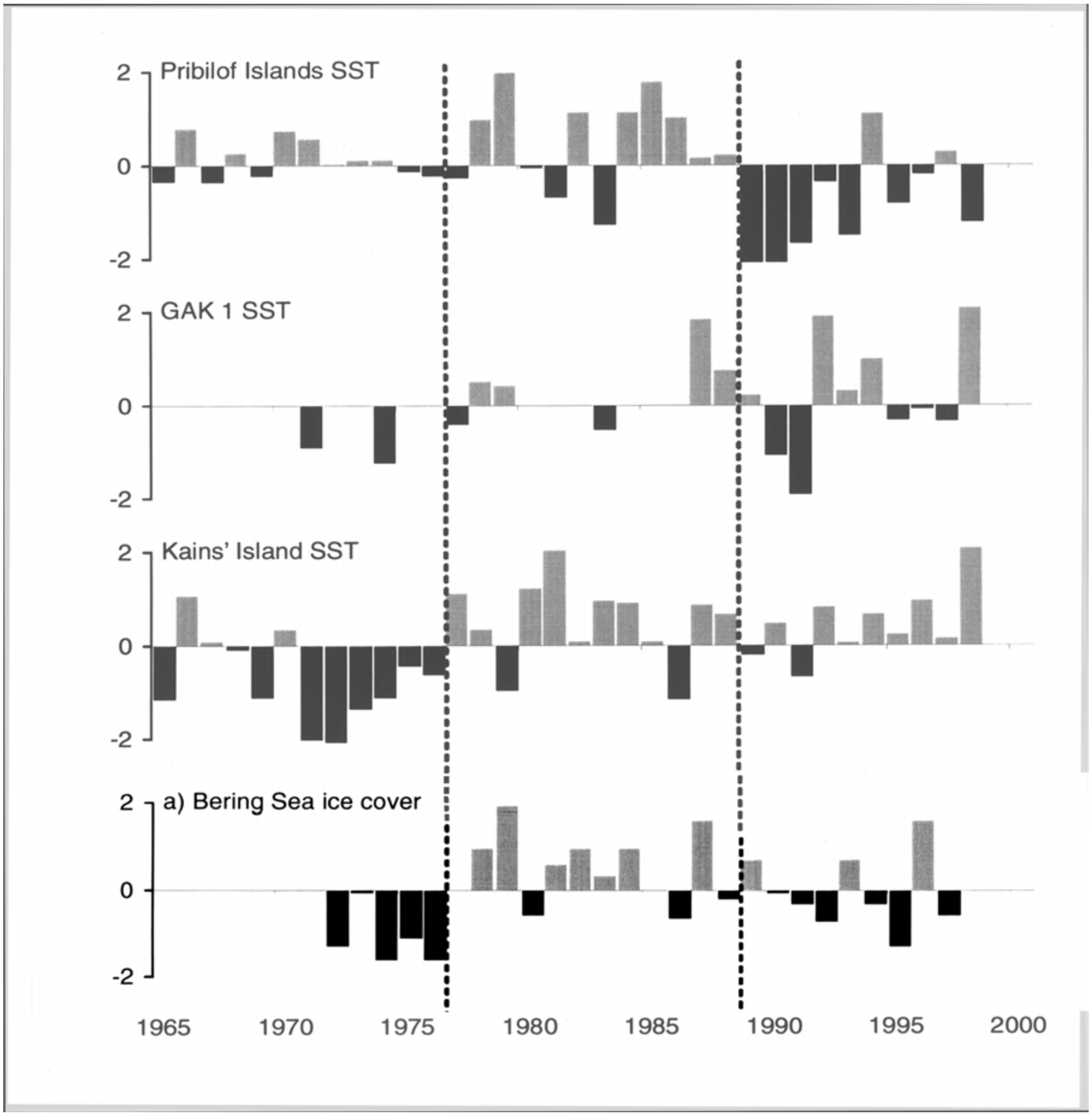


Figure 3.1-7 Winter sea surface temperature anomalies (°C) at (a) the Pribilof Islands in the EBS; (b) ocean station GAK 1 south of Seward, Alaska, in the western Gulf of Alaska; (c) Kains' Island in the southern Gulf of Alaska off the British Columbia coast; and (d) ice cover in the Bering Sea represented by the anomaly (° latitude) of the latitude of ice extent along 167°W. The ordinate (y axis) of each graph has been normalized in units of standard deviation. Source: Hare and Mantua 2000.

Sudden climate shifts in 1923, 1947, and 1976 in the North Pacific Ocean substantially altered marine ecosystems off Japan, Hawaii, Alaska, California, and Peru. Sardine stocks off Japan, California, and Peru exhibit shifts in abundance that appear to be synchronized with shifts in climate (Kawasaki 1991). These historical 60-year cycles are seen in paleoceanographic records of scales of anchovies, sardines, and hake as well. Other examples are salmon stocks in the GOA and the California Current, whose cycles are out of phase—when salmon stocks do well in the GOA they do poorly in the California Current and vice versa (Hare and Francis 1995, Mantua et al. 1997).

In addition to decadal-scale shifts, interannual events such as the ENSO can have significant impacts on fish distribution and survival, and can affect reproduction, recruitment, and other processes in ways that are not yet understood. The 1997–1998 ENSO event, one of the strongest recorded this century, significantly changed the distribution of fish stocks off California, Oregon, Washington, and Alaska, and the longer-term impacts of this event remain to be seen. Fisheries predictions are not possible in part because ENSO signals propagate to high-latitudes both through the ocean as well as through the atmosphere. Information on the dynamics of North Pacific Ocean climate and how this is linked to equatorial ENSO events is not adequate to adjust fisheries predictions for such abrupt, far-reaching, and persistent changes. Warm ocean conditions observed in the California Current during the present regime may be due, in large part, to increased frequency of ENSO-like conditions.

3.1.6.4 EBS Trophic Relationships

The biological and oceanographic dynamics of the EBS have been monitored to watch for trends and potential sources of problems, such as overfishing or fishery-induced declines. Livingston et al. (1999) reviewed the trends in the fisheries and potential impacts to the EBS ecosystems. Historical biomass trends of three different trophic guilds in the Bering Sea were examined by Livingston (NMFS 2001) to see if there was a relationship between fishing or climate in changes in total guild biomass or changes in species in the guild. For example, large fishing removals of one guild species might result in increases in other members of that guild as competitive pressures ease. Similarly, if fishing removes large numbers of a prey important to all members of the guild, an overall decrease in abundance of the guild species might be observed, as well as decreased mean size at age of predators relying on that prey. Alternatively, if the factor inducing observed change was environmental, trends in mean size at age or abundance that correlate positively or negatively with temperature or other climate factors might be seen.

Three trophic guilds have been examined by Livingston (2001):

1. offshore fish, mammals, and seabirds that consume small fish,
2. inshore fish, crab, and other benthic epifauna that primarily consume infauna, and
3. a ubiquitous group that feeds on crab and fish (Figure 3.9-4, from NMFS 2001).

Despite conservative exploitation rates, a variety of species in diverse trophic groups showed either long-term increases or decreases in abundance (e.g., arrowtooth flounder, Greenland turbot, some seabirds, and marine mammals) while both fished and unfished species have shown cyclic fluctuations in abundance over the last two decades (pollock, cod, crab, sea stars, among others). There appeared to be no link between species declines and prey abundance. The timing of some species declines, such as marine birds, were more related to increases in the adult populations of their main prey species, pollock.

Study results also show a stable trophic level of catch, and stable populations overall. The trophic level of the Bering Sea harvest has risen slightly since the early 1950s, and appeared stable as of 1994.

Other studies have also linked production, recruitment, or biomass changes in the Bering Sea with climate factors. For example, the large increase in gelatinous zooplankton in the Bering Sea has been linked to a climate regime change that might have occurred around 1990 (Brodeur et al. 1999). Recruitment in both crabs and groundfish in the Bering Sea has been linked to climate factors (Zheng et al. 1998, Rosenkranz et al. 1998, Hollowed et al. 1998, Hare and Mantua 2000). There are indications from several studies that the Bering Sea ecosystem responds to decadal oscillations and atmospheric forcing, and that the 1976–1977 regime shift had pronounced effects there. Chlorophyll concentrations did show a peak in the late 1970s, which was closely related to the increase in summer mixed-layer stability (Sugimoto and Tadokoro 1997). Also, on a decadal time scale, chlorophyll concentrations in the summer were positively correlated with winter wind speeds, indicating a positive response of Bering Sea phytoplankton to stronger Aleutian lows (Sugimoto and Tadokoro 1997).

3.1.6.5 Food Web Modelling

Food-web models of the EBS shelf ecosystem have been developed for the 1950s and 1980s (Trites et al. 1999). These models use the ECOPATH strategy for evaluating mass-balance in marine ecosystems. This model uses estimates of biomass, consumption, diet, and turnover rates of populations or groups of populations to evaluate energy flow and mass-balance in a particular ecosystem (Christensen 1990).

ECOPATH creates static biomass flow models of ecosystems, and represents a snapshot of the ecosystem for a given time period. Species in these models are linked, so that the biomass transfer resulting from processes such as fecundity, mortality, production, respiration, and predation are in equilibrium (balanced). These type models provide a way to identify large-scale views of ecosystems and highlight data gaps (Christensen 1990, 1992, 1994; Pauly and Christensen 1995).

An examination of energy flow within the ecosystem is instructive, although one must be careful in interpreting the inevitable differences among the flow estimates. For instance, although the magnitude of biomass flow from prey to tertiary consumers (e.g., juvenile pollock to seabird predators) is modest relative to that between primary producers and primary consumers (e.g., phytoplankton to crustaceans), it may nonetheless play a significant role in the dynamics of the food web. Further, if a food web is composed of few, highly connected species (in a trophic sense), removal of a predator may yield a larger ecosystem perturbation than a similar removal in an ecosystem with weaker trophic links among many predators and prey (e.g., Pimm 1982).

The ECOPATH models for the Bering Sea were developed to see if impacts of intensive whale harvesting that occurred in the 1950s and 1960s were sufficient to explain the ecosystem structure changes that were observed in the 1980s. The primary removal of energy in both decades was harvest; whales and pelagic fishes in the 1950s, and pollock in the 1980s. The production estimate for the 1950s simulation showed baleen whales as the dominant ecosystem component. These whales were classed as a midlevel consumer. They were rated slightly higher than pollock, due to their consumption of squid. The dominant component in the 1980s simulation was pollock, the dominant fishery. There was a slight drop in trophic level of the catch over time between the two periods, but this was acknowledged to be an artifact of the volume of squid assumed in the diet of the baleen whales. Without this assumption, there was little change in trophic level of harvest. Trophic level of the catch actually increases from the 1950s to the 1980s, if only fish harvests are considered. This would suggest that harvesting in the Bering Sea at present is at a level that has been sustained over long periods. A further result of this simulation was that whale harvests required an estimated 47 percent of net primary production in the Bering Sea in the 1950s. Fisheries of the 1980s, dominated by pollock, required only 6.1 percent of primary production.

Measures of ecosystem maturity show some differences between the two Bering Sea models. The ratio of primary production to respiration, net system production, and the ratio of biomass to throughput indicate a more mature ecosystem state in the 1950s compared with the 1980s. This is due to the assumption that benthic infauna biomass was lower in the 1980s. However, benthic infaunal surveys used to estimate biomass for the two models used different methodology and may not be comparable.

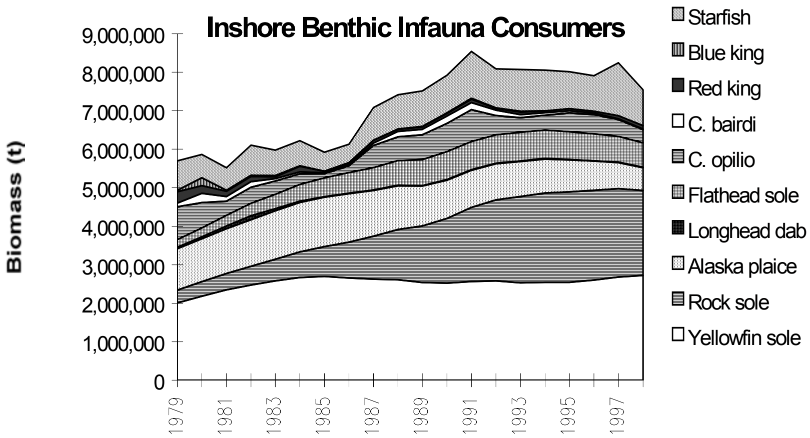
Trophic pyramids are similar for the two time periods, and both indicate that biomass and energy flow are distributed fairly well throughout the system. The steep-sided shape of the pyramids indicate that there is a lot of energy flow at lower trophic levels. One system maturity index, the ratio of primary production to total biomass, actually indicates a more mature system in the 1980s relative to the 1950s. However, this was due to assumptions about the change in primary production between the two time periods, for which there is conflicting evidence. Conclusions about system maturity are somewhat premature until trends in primary production and benthic infauna biomass are better understood.

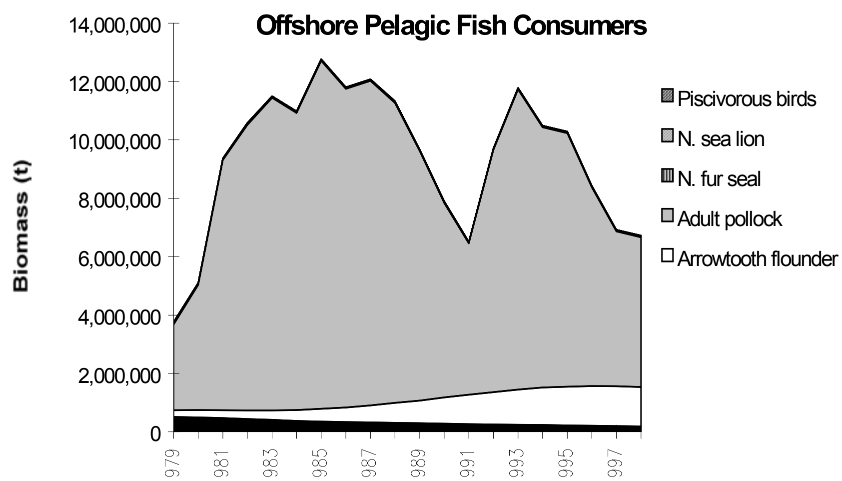
The Bering Sea appears to be more mature than other modeled ecosystems, particularly with regard to total system throughput, which measures the sum of all energy flows in the system. It also has ecosystem measures that indicate it has significant strength in reserve, which makes it more resilient or resistant to perturbations compared with other ecosystems.ECOSIM, a forward-looking simulation coupled to ECOPATH was used to project the results of various scenarios. The model was run in either an equilibrium or dynamic mode. The equilibrium mode assumed that the total biomass of the ecosystem remained stable, and as the biomass of one component declined, others were required to increase to balance it. Dynamic models do not have this requirement.

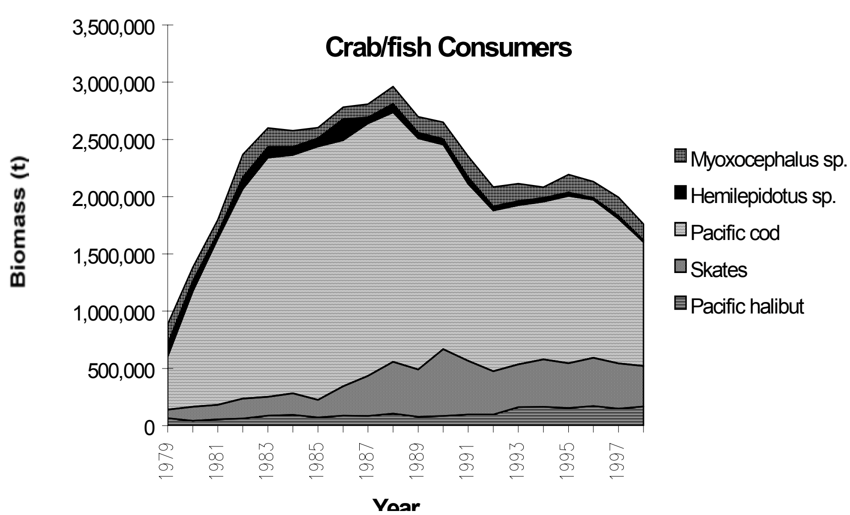
The equilibrium mode of ECOSIM was used to examine the results of changes in a species' abundance on interacting groups. The results of the equilibrium model suggest that changes in baleen whale numbers could significantly affect pollock populations; increases in sperm whale numbers could yield decreases in the numbers of Steller sea lions through competition. Reducing pelagic fish numbers reduces the numbers of seabirds that feed on them, as well as numbers of Steller sea lions and large flatfish. Increasing fishing pressure on pollock would have little effect on their biomass,and increasing fishing pressure on large flatfishes would result in increased Steller sea lion populations through the removal of a competitor.

In a different approach, the dynamic mode of ECOSIM was used to look at possible mechanisms involved in the historical marine biomass changes seen between the 1950s and the 1980s. Scenarios used for the dynamic model were a regime shift that resulted in changes in primary production; a commercial fishery simulation to see if fishing whale could account for the observed changes; three pollock fishing scenarios that project into the future; and scenarios which varied the fishery mortalities on pollock and pelagic fishes.

.


Inshore Benthic Infauna Consumers
Biomass (t)
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
Starfish
Blue king
Red king
C. bairdi
C. opilio
Flathead sole
Longhead dab
Alaska plaice
Rock sole
Yellowfin sole


Offshore Pelagic Fish Consumers
Biomass (t)
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
Piscivorous birds
N. sea lion
N. fur seal
Adult pollock
Arrowtooth flounder


Crab/fish Consumers
Biomass (t)
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
Year
Myoxocephalus sp.
Hemilepidotus sp.
Pacific cod
Skates
Pacific halibut

These simulations suggested that commercial harvesting of fish and whales had little likelihood of producing the changes seen in actual pollock populations since the 1950s. The effect of increasing primary production provided a much more realistic change in the pollock population. While most groupings showed increases, Steller sea lions did not.

There are substantial uncertainties about the abundance of small pelagic fish in both time periods and the abundance of pollock in the 1950 s model. Low abundance of pollock and higher abundance of small pelagic fish in the 1950s was assumed. However, although nonstandardized surveys by the Soviets during the 1950s showed apparently lower pollock abundance, their research on diet composition of groundfish indicated that pollock was a primary prey item of many species. It is possible that pollock may have been more abundant in the 1950s than has been assumed. Further model testing with this change in assumptions should be done.

Another dynamic simulation showed that, contrary to what might be expected, stopping the commercial pollock harvest had a slight negative effect on Steller sea lions. This is because two of the Steller sea lion prey items, small pelagic fish and juvenile pollock, declined when adult pollock increased (adult pollock are cannibalistic and compete with small pelagic fish for large zooplankton prey in this model). More recent versions of the model (which changed the assumptions regarding recruitment) now show that juvenile pollock actually increase under this scenario but Steller sea lions still show a slight negative effect. This is presumably because of the assumption of the dominance of small pelagic fish as a prey item of Steller sea lions. Small pelagic fish still decline under the assumption of increasing pollock because adult pollock compete with them for large zooplankton prey. A similar effect might be expected for northern fur seals as for Steller sea lions.

Thus, these model simulations indicated uncertainty about the biomass of lower trophic level species in the two time periods. It appeared that climate-related shifts in lower trophic level production could partly explain the ecosystem changes that occurred between the 1950s and the 1980s. However, the model only captures predation-related recruitment variability and cannot show the climate-related variability in recruitment, which is probably much larger. More detailed scenarios that examine the spatial availability of prey may need to be performed to better understand the complex interaction between fishery removals and predator-prey interactions.

In summary, evidence from present and past observations and modeling studies at the community and ecosystem levels in the BSAI suggest climate-driven changes are responsible for a great deal of the multispecies and ecosystem level changes that have been observed. Modeling studies have helped us understand the possible long term implications of various fishing strategies by including trophic interactions between ecosystem components. The models showed the largest differences in predictions from single species models with respect to prey species. As with all of the models, these models are sensitive to assumptions about recruitment. These models could be improved by linking them to predictive models that include climate effects on species. However, these types of predictive models are still lacking for most species in the ecosystem and climate changes are too unpredictable.

3.2 Biological Resources

3.2.1 Marine Mammals

The Bering Sea and Aleutian Islands (BSAI) support one of the richest assemblages of marine mammals in the world. Twenty-seven species are present from the orders Pinnipedia (seals, sea lion, and walrus) and Cetacea (whales, dolphins, and porpoises)(Lowry and Frost 1985, Springer et al. 1999). Of these, 17 species are cetaceans: whales, dolphins or porpoises; and 10 species are pinnipeds; seals, sea lions and walrus. Polar bears and sea otters (Order Carnivora) are also present.

Most species are resident throughout the year, while others seasonally migrate into or out of the area. Marine mammals occur in diverse habitats, including deep oceanic waters, the continental slope, and the continental shelf (Lowry et al. 1982). Following are brief descriptions of the range, habitat, diet, abundance, and population status of species relevant to this analysis.

3.2.1.1 ESA Listed Marine Mammals

Seven species of large whales that occur in Alaska are listed under the ESA including the following: the northern right whale, fin whale, sei whale, blue whale, sperm whale, bowhead whale and the humpback whale. None of these species are affected by the proposed action either individually or as part of a larger cumulative effect of the action on the environment. They are not considered further in this review.

The western population of Steller sea lions is the only pinniped species listed under the ESA and found in Alaska. This species will be further addressed in section 3.2.1.4.

3.2.1.2 Other Cetacea

A large number of small cetaceans are found in the action area including beluga whales, killer whales, Pacific white-sided dolphins, harbor porpoises, and Dall's porpoises, and several species of beaked whales. None of these species are affected by the proposed action either individually or as part of a larger cumulative effect of the action on the environment. They are not considered further in this review

3.2.1.3 Carnivora

Neither the sea otter (family Mustelidae) nor the polar bear (family Ursidae) are affected by the proposed action either individually or as part of a larger cumulative effect of the action on the environment. They are not considered further in this review.

3.2.1.4 Pinnipedia

Three families of pinnipeds are represented: Otariidae, the eared seals (Steller sea lion and northern fur seal); Odobenidae, the Pacific walrus; and Phocidae, the true seals (harbor, spotted, bearded, ringed, ribbon). The northern fur seal and Steller sea lion will be discussed in greater detail due to parallels in their life-history and trends.

Northern Fur Seals

The northern fur seal (*Callorhinus ursinus*) ranges throughout the North Pacific Ocean from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan. Breeding is restricted to only a few sites: the Commander and Pribilof Islands, Bogoslof Island, and the Channel Islands (NMFS 1993).

Northern fur seals pup, mate, and wean on land in isolated rookeries, but spend the remainder of their lives at sea. On the Pribilof Islands, lactating females usually forage within 160 km of the rookeries, but occasionally as far away as 430 km (Goebel et al. 1991). Pups are weaned in October and November, at about 125 days old, and go to sea soon afterward (Gentry and Kooyman 1986). Most females, pups, and juveniles leave the Bering Sea by late November and migrate south as far as Southern California in the eastern North Pacific and Japan in the western North Pacific. They remain pelagic offshore and along the continental shelf until March, when they begin returning to the rookeries. Adult males are believed to migrate only as far south as the GOA (Kajimura and Fowler 1984).

(i) __Abundance Estimate__: The population estimate for the Eastern Pacific stock of northern fur seals is calculated as the estimated number of pups at rookeries multiplied by a series of different expansion factors determined from a life table analysis to estimate the number of yearlings, 2 year olds, 3 year olds, and animals at least 4 years old (Lander 1981). The resulting population estimate is equal to the pup count multiplied by 4.5. The expansion factor is based on a sex and age distribution estimated after the harvest of juvenile males was terminated. Currently, CVs are unavailable for the expansion factor. As the great majority of pups are born on the Pribilof Islands, pup estimates are concentrated on these islands, though additional counts are made on Bogoslof Island. Since 1990, pup counts have occurred biennially on St. Paul and St. George Islands, although less frequently on Sea Lion Rock and Bogoslof Island. In 1992, 1994, 1996, 1998, 2000, and 2002 pup counts on the Pribilof Islands and Bogoslof Island were ‑228,711 (CV = 0.036), and 211,673 (CV = 0.100), 219,226, 198,899 (CV = 0.088), 196,899 (CV = 0.089), and 175,955 (CV = 0.010), respectively (Antonelis et al. 1994, 1996; York et al. 1997, 1998; Ream et al. 1999). The average mean pup count for 1998, 2000, and 2002 is 197,360. Therefore, the most recent estimate for the number of fur seals in the Eastern Pacific stock is approximately 888,120 (4.5 × 197,360).

(ii) __Minimum Population Estimate (Nmin)__: A CV(N) that incorporates the variance due to the correction factor is not currently available. Consistent with a recommendation of the Alaska Scientific Review Group (SRG) and recommendations contained in Wade and Angliss (1997), a default CV(N) of 0.2 was used in the calculation of the minimum population estimate (N_{MIN}) for this stock (DeMaster 1998). N_{MIN} is calculated using Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the population estimate (N) of 888,120 and the default CV (0.2), N_{MIN} for the Eastern Pacific stock of northern fur seals is 751,714.

(iii) __Current Population Trend__: The Alaska population of northern fur seals increased to approximately 1.25 million in 1974 after the killing of females in the pelagic fur seal harvest was terminated in 1968. The population then began to decrease with pup production declining at a rate of 6.5-7.8% per year into the 1980s (York 1987a). By 1983 the total stock estimate was 877,000 (Briggs and Fowler 1984). Annual pup production on St. Paul Island has remained relatively stable between 1981 and 1995, indicating that stock size has not changed much in recent years (York and Fowler 1992). The 1996 estimate of number of pups born on St. Paul Island is not significantly different from the 1990, 1992, or 1994 estimates (York et al. 1997). However, the 2000 estimate of the number of pups born was 10% less than the 1992 count and 6% less than the 1996 count. Although there was a slight increase in the number of pups born on St. George Island in 1996, the number of pups born declined between 1996 and 1998, and the 1998 counts were similar to those obtained in 1990, 1992, and 1994. During 1998-02, pup production declined 5.14% per year (SE = 0.26%) on St. Paul Island and 5.35% per year (SE = 0.19%) on St. George Island. Counts in both 2000 and 2002 were lower than previous years; the estimated pup production is now below the 1921 level on St. Paul Island and below the 1916 level on St. George Island.

(iv) Current and Maximum Net Productivity Rates: The northern fur seal population increased steadily during 1912-24 after the commercial harvest no longer included pregnant females. During this period, the rate of population growth was approximately 8.6% (SE = 1.47) per year (A. York unpubl. data, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115), the maximum recorded for this species. This growth rate is similar and slightly higher than the 8.12% rate of increase (approximate SE = 1.29) estimated by Gerrodette et al. (1985). Though not as high as growth rates estimated for other fur seal species, the 8.6% rate of increase is considered a reliable estimate of R_{MAX} given the extremely low density of the population in the early 1900s.

(v) Potential Biological Removal: Under the 1994 amendments to the MMPA, the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for depleted stocks under the MMPA (Wade and Angliss 1997). Thus, for the Eastern Pacific stock of northern fur seals, PBR = 16,162 animals (751,714 × 0.043 × 0.5).

(vi) Diet of Fur Seals: Studies on northern fur seal diets began with the work of Lucas (1899). The most extensive research was based on the pelagic sampling of over 18,000 fur seals between 1958 and 1974 (Perez and Bigg 1986). Of the fur seal stomachs collected, 7,373 contained food and an additional 3,326 had trace remains. The diet consists of 67 percent fish (34 percent pollock, 16 percent capelin, 6 percent Pacific herring, 4 percent deep-sea smelt and lantern fish, 2 percent salmon, 2 percent Atka mackerel, and no more than 1 percent eulachon, Pacific cod, rockfish, sablefish, sculpin, Pacific sand lance, flatfish, and other fish) and 33 percent squid (Perez 1990). These data showed marked seasonal and geographic variation in the species consumed. In the eastern Bering Sea, pollock, squid, and capelin accounted for about 70 percent of the energy intake. In contrast, sand lance, capelin, and herring were the most important prey in the GOA.

Based on diet studies conducted since the early pelagic collections (Sinclair et al. 1994, Sinclair et al. 1996, Antonelis et al. 1997), some prey items, such as capelin, have disappeared entirely from fur seal diets in the EBS and squid consumption has been markedly reduced. At the same time, pollock consumption has tripled, while the age category of pollock eaten has decreased. Consumption of pollock, gonatid squid, and bathylagid smelt in the eastern Bering Sea has, however, remained consistently important in all diet studies, despite the wide variety of prey available to fur seals within their diving range.

Stomach contents of 73 northern fur seals collected from the Bering Sea—7 in 1981, 43 in 1982, and 43 in 1985—indicated consumption of nearly 100 percent fish (1981), 88 percent fish and 12 percent squid (1982), and 88 percent fish and 12 percent squid (1985) (Sinclair et al. 1994). Analysis of these data showed that pollock and squid were the most frequently eaten prey in the EBS, and that a positive correlation exists between pollock year-class strength and the frequency of pollock in fur seal diets (Sinclair et al. 1994). The same report concluded that northern fur seals are size-selective midwater feeders during the summer and fall in the eastern Bering Sea. Since 1987, studies of northern fur seal diets have been based on fecal samples (scat). A comparative study of fur seal diets based on the current method of scat analysis versus stomach content analysis from the 1980s collections (Sinclair et al. 1996) demonstrated that pollock represented 79 percent of all prey for all years combined in gastrointestinal tracts, and 78 percent of the total prey in fecal samples. The frequency of pollock occurrence in all years averaged 82 percent in gastrointestinal tracts and 76 percent in fecal samples (Sinclair et al. 1996).

Based on the pelagic collections from the 1970s, annual food consumption by the northern fur seal population in the EBS was 432.4×10^3 mt, of which 289.7×10^3 mt represented fish species. Of the total annual fish consumption, commercial groundfish comprised 56 percent, which was an estimated 0.7 percent of the standing biomass of commercial groundfish consumed (i.e., by all predators combined) annually in the eastern Bering Sea (Perez and McAlister 1993). Based on data collected in the 1980s, groundfish consumption has increased as forage fishes have decreased (Sinclair et al. 1994; 1996). Trites (1992) estimated that 133,000 mt of walleye pollock (ages 1 to 2) are consumed annually by northern fur seals in the eastern Bering Sea.

(vii) Status: Depleted Determination

On 17 June 1988, NMFS declared the Pribilof Islands (St. Paul and St. George Islands) stock of northern fur seals depleted under the MMPA because it declined to less than 50 percent of levels observed in the late 1950s and, at that time, there was no compelling evidence that carrying capacity (K) had changed substantially since the late 1950s. The most likely causes of the decline of fur seals was the harvest of adult females from 1956 to 1968, and the lower survival of juveniles and adult females at sea since 1975. Emigration did not contribute to the decline because the species has declined in total numbers throughout its range.

The MMPA defines the term "depletion" or "depleted" (16 U.S.C.1362) as meaning any case in which "(A) the Secretary of Commerce, after consultation with the Marine Mammal Commission (MMC) and the Committee of Scientific Advisors on Marine Mammals established under title II of this Act, determines that a species or population stock is below its optimum sustainable population; (B) a State, to which authority for the conservation and management of a species or population"stock is transferred under U.S.C. 1379, determines that such species or stock is below its optimum sustainable population; or (C) a species or population stock is listed as an endangered species or a threatened species under the Endangered Species Act of 1973 (16 U.S.C. 1531 ~ ~)."

The MMPA further defines optimum sustainable population (OSP) as "...with respect to any population stock, the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the optimum carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element (1362(8))."

NMFS regulations at *50* CFR 216.3 define OSP as "...a population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem (K), to the population level that results in maximum net productivity (MNPL). MNPL is the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth losses due to natural mortality ."

Section (1361(2)) of the MMPA states that marine mammal species, populations and/or stocks should not be permitted to fall below their asp level. The MNPL is the lower end of OSP. Therefore, to be within OSP, the ratio of current to historic levels should be at or above the maximum rate of pup production (or MNPL). Historically, MNPL has been expressed as a range of values (generally 50-70 percent of K) determined theoretically by estimating what stock size in relation to the original stock size will produce the maximum net increase in population (42 FR 12010, March 1, 1977). MNPL for marine mammals is at least 50 percent of carrying capacity (Eberhardt and Siniff, 1977), and may be as high as 80 percent (Fowler 1981, 1988). In 1977, the mid-range value of 60 percent was used to determine if a stock of dolphins was depleted (42 FR 64548, Dec. 27, 1977). The 60 percent value was supported by NMFS in the final rule governing the taking of marine mammals incidental to commercial fishing operations (45 FR 72178, Oct. 31, 1980). The lower bound of OSP for northern fur seals is also considered to be at 60 percent of K (Fowler, 1981).

(viii) Conservation Plan : Amendments to the MMPA passed into law on 23 November 1988 (P.L. 100-711) direct the Secretary of Commerce to develop a conservation plan on northern fur seals for "conserving and restoring the species or stock to its optimum sustainable population." A conservation plan delineates reasonable actions to protect a depleted species under the Marine Mammal Protection Act (MMPA). Plans are prepared by NMFS, often with the assistance of planning groups or teams, contractors, state agencies, and others. The amendments further specify that a plan serves as a guide that delineates and schedules those actions believed necessary to restore the northern fur seal to pre-depleted levels of abundance. These actions are outlined in the Implementation Schedule of a conservation plan. Approved plans are subject to modification as dictated by new findings, changes in species status and completion of implementation tasks. Goals and objectives will be attained and funds expended contingent upon agency appropriations and priorities.

The Pribilof Islands Northern Fur Seal Conservation Plan was signed by the AA, and published by NMFS in June 1993. This Conservation Plan represents the official position of NMFS and includes information on the status of fur seals on the Pribilof Islands, causes of declines, threats to the species, critical information gaps, and recommended research and management actions for meeting the objectives of the plan. As it has been a decade since its publication, a revision to the Conservation Plan is being considered by NMFS and the Tribal Governments at this time. The goal of any Conservation Plan will be met when the depleted stock (in this case, northern fur seals) has increased to the level where it can be removed as depleted under MMPA listings.

Steller Sea Lions in the EBS

The Steller sea lion (*Eumetopius jubatus*) ranges along the North Pacific Ocean rim from northern Japan to California (Loughlin et al. 1984), with centers of abundance and distribution in the GOA and Aleutian Islands, respectively. The northernmost breeding colony in the Bering Sea is on Walrus Island near the Pribilof Islands.

Habitat includes both marine waters and terrestrial rookeries (breeding sites) and haulouts (resting sites). Pupping and breeding occur during June and July in rookeries on relatively remote islands, rocks, and reefs. Females generally return to the rookeries where they were born to mate and give birth (Alaska Sea Grant 1993, Calkins and Pitcher 1982, Loughlin et al. 1984). Although most often found within the continental shelf region, they may be found in pelagic waters as well (Bonnell et al. 1983, Fiscus et al. 1976, Kajimura and Loughlin 1988, Kenyon and Rice 1961, Merrick and Loughlin 1997).

Observations of Steller sea lions at sea suggest that large groups usually consist of females of all ages and subadult males; adult males sometimes occur in those groups but are usually found individually. On land, all ages and both sexes occur in large aggregations during the nonbreeding season. Breeding season aggregations are segregated by sexual and territorial status. Steller's sea lions are not known to migrate, but they do disperse widely at times of the year other than the breeding season. For example, sea lions marked as pups in the Kuril Islands (Russia) have been sighted near Yokohama, Japan (more than 350 km away) and in China's Yellow Sea (over 750 km away). Generally, animals up to about 4 years of age tend to disperse farther than adults. As they approach breeding age, they have a propensity to stay in the general vicinity of the breeding islands, and, as a general rule, return to their island of birth to breed as adults.

The foraging patterns of adult females vary seasonally. Trip duration for females with young pups in summer is approximately 18 to 25 hours. Trip length averages 17 km, and they dive approximately 4.7 hours per day. In winter, females may still have a dependent pup, but a mean trip duration is about 200 hours. During winter, a mean trip length is about 130 km, and dives total about 5.3 hours per day (Merrick and Loughlin 1997). In winter, yearling sea lions in winter exhibit foraging patterns about half the distance of those females made between summer and winter (mean of 30 km), but shorter in duration (mean of 15 hours), and with less effort devoted to diving (mean of 1.9 hours per day). Estimated home ranges are 320 km^2 for adult females in summer, about 47,600 km^2 (with large variation) for adult females, and 9,200 km^2 for yearlings in winter (Merrick and Loughlin 1997).

Compared to other pinnipeds, Steller sea lions tend to make relatively shallow dives, with few dives recorded to depths greater than 250 m. Maximum depths recorded for individual adult females in summer range from 100 to 250 m; maximum depth in winter is greater than 250 m. The maximum depth measured for yearlings in winter was 72 m (Merrick and Loughlin 1997, Swain and Calkins 1997).

Steller sea lions give birth to a single pup each year; twinning is rare. Males establish territories in May in anticipation of the females' arrival (Pitcher and Calkins 1981). Viable births begin in late May and continue through early July; the sex ratio at birth is slightly in favor of males. Females breed again about two weeks after giving birth. Copulation may occur in the water, but mostly occurs on land (Pitcher and Calkins 1998, Gentry 1970, Gisiner 1985). The mother nurses the pup during the day. She stays with her pup for the first week, then goes to sea on nightly feeding trips. Pups generally are weaned before the next breeding season, but it is not unusual for a female to nurse her offspring for a year or more. Females reach sexual maturity between three and eight years of age and may breed into their early twenties. Females can have a pup every year but may skip years as they get older, or when nutritionally stressed. Males also reach sexual maturity at about the same ages but do not have the physical size or skill to obtain and keep a breeding territory until they are nine years of age or older. Males may return to the same territory for up to seven years, but most return for no more than three years (Gisiner 1985). During the breeding season, males may not eat for 1 to 2 months. The rigors of fighting to obtain and hold a territory and the physiological stress of the mating season reduces their life expectancy. Males rarely live beyond their mid-teens, while females may live as long as 30 years.

In the Bering Sea, the Steller sea lion diet consists of a variety of schooling fishes (e.g., pollock, Atka mackerel, Pacific cod, flatfish, sculpin, capelin, Pacific sand lance, rockfish, Pacific herring, and salmon), as well as cephalopods, such as octopus and squid (Calkins and Goodwin 1988, Lowry et al. 1982, Merrick and Calkins 1995, Perez 1990). Recent analyses of fecal samples collected on Steller sea lion haulouts and rookeries suggest that Atka mackerel is particularly important for Steller sea lions in the central and western Aleutian Islands—over 70 percent of the animals' summer diet in this area is Atka mackerel. Pollock represent over 60 percent of the diet in the central GOA, 29 percent in the western GOA and eastern Aleutian Islands, and over 35 percent in parts of the central Aleutian Islands (Merrick and Calkins 1995). Small pollock (less than 20 cm) appear to be more commonly eaten by juvenile sea lions than older animals (Merrick and Calkins 1995).

The total estimated annual food consumption by the Steller sea lion population in the eastern Bering Sea is 185.2×10^3 mt, of which 140.7×10^3 mt (76 percent) is fish. Of the total annual fish consumption, commercial groundfish comprise 69 percent, or 0.4 percent of the standing biomass consumed annually by all predators combined in the eastern Bering Sea (Perez and McAlister 1993).

Daily consumption of herring by captive sea lions was estimated to be between 5.61 and 8.07 kg (Rosen and Trites 1998). In an attempt to predict the nutritional importance of pollock versus herring in the diet of the Steller sea lion, Fadley et al. (1994) reported daily consumption of these two prey items by captive California sea lions (*Zalophus californianus*): each animal consumed 5.2–8.2 kg of herring and 7.8–12.0 kg of pollock daily.

(i) Status: The count of adult and juvenile Steller sea lions in Alaska during 1996 to 1998 was 40,565 (Alaskan western stock = 29,658), with a total for the state of 52,602 including pups (Sease and Loughlin 1999). In the late 1950s and early 1960s, the total North Pacific population was estimated to be about 240,000 to 300,000 (Kenyon and Rice 1961). Steller sea lions are currently managed as two distinct stocks, eastern and western (Loughlin 1997). Abundance of the U.S. eastern stock remained relatively stable from the 1960s to 1985 at around 13,000 to 15,000 (not counting pups) and has since increased to nearly 19,000 (excluding pups). The U.S. western stock, on the other hand, has continuously declined since the 1960s, from around 177,000 (excluding pups) in the 1960s to 33,600 (excluding pups) in 1994. In the 1960s, the western stock included 92 percent of the U.S. population, but by 1994 this proportion had declined to 64 percent (Loughlin et al. 1992, Merrick et al. 1987).

In 1990, the Steller sea lion was listed as threatened under the Endangered Species Act (ESA) throughout its range (55 FR 12645, 55 FR 13488, 55 FR 49204, 55 FR 50005). A recovery plan was completed in 1992. In 1997, the National Marine Fisheries Service (NMFS) reclassified Steller sea lions as two distinct population segments under the ESA (62 FR 24345). The population segment west of 144°W, or approximately at Cape Suckling, was reclassified as endangered. The eastern stock remains listed as threatened.

Other Pinnipeds in the EBS and BSAI

(i) Pacific Walrus: The Pacific walrus (*Odobenus rosmarus*) occurs primarily in the shelf waters of the Bering and Chukchi Seas (Allen 1980, Smirnov 1929). Most of the population congregates during the summer in the southern edge of the Chukchi Sea pack ice between Long Strait, Wrangell Island, and Point Barrow (Fay et al. 1984). The remainder of the population, primarily adult males, stays in the Bering Sea during summer (Brooks 1954, Burns 1965, Fay 1955, Fay 1982, Fay et al. 1984).

The species is not listed under the ESA and has no special status under the MMPA. Round Island, one of the most important terrestrial haulouts in the United States, is a state preserve and federal regulations prohibit entry of fishing vessels inside 12 miles (672.22(a)(4)).

(ii) Harbor Seals: Harbor seals (*Phoca vitulina*) inhabit coastal and estuarine waters off Baja California, north along the western coasts of the United States, British Columbia, and southeast Alaska, west through the GOA and Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. They haul out on rocks, reefs, beaches, and drifting glacial ice, and feed in marine, estuarine, and, occasionally, fresh waters. Major food items vary by availability and include sand lance, smelt, sculpins, herring, capelin, shrimp, mysids, octopus, pollock, and flatfishes (Lowry et al. 1982).

Three separate harbor seals stocks are recognized in Alaska waters: (1) the southeast Alaska stock, occurring from the Alaska/British Columbia border to Cape Suckling; (2) the GOA stock, occurring from Cape Suckling to Unimak Pass, including animals throughout the Aleutian Islands; and (3) the Bering Sea stock, including all waters north of Unimak Pass (Hill and DeMaster 1999). Population sizes and mortality rates in fisheries are calculated separately.

The Bering Sea stock was surveyed during the autumn molt of 1995 throughout northern Bristol Bay and along the north side of the Alaska Peninsula (Withrow and Loughlin 1996). The estimated abundance, corrected for animals in the water, is 13,312 (Hill and DeMaster 1999). NMFS observers monitored incidental take in the BSAI groundfish trawl, longline, and pot fisheries. The mean annual (total) mortality was 2.2 for the BSAI groundfish trawl fishery, 0.6 for the BSAI longline fishery, and 1.2 for the BSAI pot fishery, a total of 4 harbor seals (Hill and DeMaster 1999).

(iii) Spotted Seals: Spotted seals (*Phoca largha*) are distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk Seas south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). They are known to occur around the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands. Of eight known breeding areas, three occur in the Bering Sea. Only the Alaska stock is recognized in U.S. waters.

Preferred habitat for spotted seals is the "front zone" of pack ice, generally rectangular floes 10–20 m in diameter with brash ice or open water inbetween (Burns 1970, Burns 1981a). When pack ice is absent, the habitat requirements of spotted seals are similar to those of harbor seals.

A reliable estimate of spotted seal population abundance is currently not available (Rugh et al. 1995). Early estimates of the world population were in the range of 334,000 to 450,000 animals (Burns 1973). The population of the Bering Sea, including Russian waters, was estimated to be 200,000 to 250,000, based on the distribution of family groups on ice during the mating season (Burns 1973). However, comprehensive systematic surveys were not conducted to obtain these estimates. Ice-associated seals, such as the spotted seal, are particularly sensitive to changes in weather and sea-surface temperatures, which strongly affect their ice habitat. Data are insufficient to make reliable predictions of the effects of arctic climate change on the Alaska spotted seal stock.

(iv) <u>Bearded Seals</u>: Bearded seals (*Erignathus barbatus*) are circumpolar in their distribution, extending from the Arctic Ocean south to Hokkaido in the western Pacific. In Alaskan waters, bearded seals occur on the continental shelves of the Bering, Chukchi, and Beaufort Seas (Burns 1981a, Johnson et al. 1966, Ognev 1935).

Only Alaska bearded seal stock is recognized in U.S. waters. Early estimates of the Bering-Chukchi Sea population range from 250,000 to 300,000 (Burns 1981a, Burns 1981b, Burns et al. 1981, Popov 1976). Until additional surveys are conducted, reliable estimates of abundance are considered unavailable. Reliable data on trends in population abundance are likewise unavailable.

(v) <u>Ringed seals</u>: Ringed seals (*Phoca hispida*) have a circumpolar distribution in all Arctic Ocean waters (King 1983). In the eastern North Pacific Ocean, they are found in the southern Bering Sea and range as far south as the seas of Okhotsk and Japan. They have an affinity for ice-covered waters and are well adapted to occupying seasonal and permanent ice. They remain in contact with ice most of the year and pup on the ice in late winter and early spring (McLaren 1985).

Only the Alaska stock is recognized in U.S. waters. A reliable abundance estimate for the Alaska stock of ringed seals is currently not available (Hill and DeMaster 1999). Crude estimates of the world population have ranged from 2.3 to 7 million, with 1 to 1.5 million in Alaskan waters (Kelly 1988). The most recent abundance estimates are based on aerial surveys conducted in 1985, 1986, and 1987 by Frost et al. (1988), but these surveys covered only a limited portion of the stock's geographic range. Reliable data on population abundance trends for the Alaska stock are also unavailable. The concern previously expressed regarding regional weather patterns for spotted and bearded seals applies to ringed seals as well.

(vi) <u>Ribbon Seals</u>: Ribbon seals (*Phoca fasciata*) inhabit the North Pacific Ocean and adjacent fringes of the Arctic Ocean. In Alaskan waters, ribbon seals are found in the open sea, on the pack ice, and on shorefast ice (Kelly 1988). They range northward from Bristol Bay in the Bering Sea into the Chukchi and western Beaufort Seas (Braham et al. 1984, Burns 1970, Burns 1981b).

Only the Alaska stock is recognized in U.S. waters. A reliable abundance estimate for the Alaska stock of ribbon seals is currently not available (Hill and DeMaster 1999). Burns (1981b) estimated the worldwide population of ribbon seals at 240,000 in the mid-1970s, with an estimate for the Bering Sea at 90,000 to 100,000. Reliable data on trends in population abundance for the Alaska stock of ribbon seals are unavailable. The concern previously expressed regarding regional weather patterns for spotted, beared, and ringed seals applies to ribbon seals as well.

3.3 Seabirds

Seabirds spend the majority of their life at sea rather than on land. The group includes albatrosses, shearwaters, petrels (*Procellariiformes*), cormorants (*Pelecaniformes*), and two families of *Charadriiformes*, gulls (*Laridae*), and auks (*Alcidae*), such as puffins, murres, auklets, and murrelets. Several species of sea ducks (*Merganini*) also spend much of their lives in marine waters.

Other bird groups contain pelagic members, such as swimming shorebirds (*Phalaropodidae*), but they seldom interact with groundfish fisheries, and therefore will not be further discussed.

Thirty-eight species of seabirds breed in Alaska. More than 1,600 colonies have been documented, ranging in size from a few pairs to 3.5 million birds. The U.S. Fish and Wildlife Service (USFWS) is the lead federal agency for managing and conserving seabirds and is responsible for monitoring the distribution and abundance of populations. Breeding populations are estimated to contain 36 million individual birds in the Bering Sea and 12 million in GOA; total population size (including subadults and nonbreeders) is estimated to be approximately 30 percent higher. Five additional species that occur in Alaskan waters during the summer months contribute another 30 million birds.

Population trends are monitored at 3 to 14 colonies per species. The sizes of breeding populations of seabirds in the GOA, eastern BSAI are not static. There have been considerable changes in the numbers of seabirds breeding in Alaskan colonies since the original counts made in the mid-1970s. Trends are reasonably well known for species that nest on cliffs or flat ground such as fulmars, cormorants, glaucous-winged gulls, kittiwakes, and murres, and for storm-petrels and tufted puffins. Trends are known for one or two small areas of the state for pigeon guillemots, two areas for murrelets, and two areas for auklets. Not known are trends for other species (jaegers, terns, most auklets, and horned puffins, Byrd and Dragoo 1997, Byrd et al. 1998, 1999). Population trends differ among species. Trends in many species vary independently among areas of the state, due to differences in food webs and environmental factors.

None of these species will be directly or indirectly affected by the alternatives considered in this proposed action.

3.3.1 ESA Listed Seabirds

Three species of marine birds found in the BSAI are listed under the ESA: the short-tailed albatross (Endangered); spectacled and Steller's eider (Threatened). None of these species will be directly or indirectly affected by the alternatives considered in this proposed action.

3.4 Commercial Fisheries Within the BSAI

3.4.1 Fisheries in the BSAI Prior to 1970

The groundfish fisheries in the BSAI and GOA were developed by Russian and Japanese fishermen between the 1959 and 1976 (except for halibut). Prior to 1976, there was virtually no domestic involvement in these fisheries.

The Soviets began commercial fishing operations off Alaska in 1959, however, no catch statistics were provided until 1964 when the U.S.S.R. began to provide these data to the Food and Agricultural Organization (FAO) of the United Nations. Obtaining accurate fishing mortality data was a general problem of the foreign distant water fisheries off Alaska. Pruter (1976) estimated that the cumulative catch of bottomfish by all nations during the period 1954-1974 amounted to over 22 million mt, of which Japan accounted for over 15 million mt (67 percent), the USSR accounted for about 6 million mt (25 percent) and the U.S. for about 1.5 million mt (6 percent). The remainder of the catch was taken by other nations like South Korea, Poland, East Germany, West Germany, China (Taiwan), and Canada. Historical catches of groundfish and squid taken in BSAI, and GOA.

The U.S. lifted restrictions on Japanese fleets in U.S. waters in 1952. In 1954, Japanese fishing fleets returned to the BSAI with 2 to 4 mothership fleets and up to three independent trawlers. Until 1957, these vessels fished for yellowfin sole and other flounder off Bristol Bay (Bakkala et al. 1981). From 1958 to 1963, the Japanese fleets expanded throughout the Bering Sea and included sablefish, Pacific ocean perch, and herring in the fishery, although yellowfin sole was still their principal focus (Bakkala et al. 1981). These catch statistics reveal the growth and magnitude of the foreign groundfish harvest off Alaska during the late-1950s through the early-1970s. Of particular note were the high catches of the yellowfin sole fishery in the Bering Sea, which peaked in 1962, and the high catches of slope rockfish (e.g. Pacific ocean perch) in the GOA during the period 1963-1968. Both of these stocks were overfished, and while yellowfin sole is believed to have recovered, slope rockfish are still recovering.

From 1960 to 1962, this fishery landed between 421,000 and 554,000 mt annually. The total catch in the eastern Bering Sea rose sharply in the mid- to late-1960s when large, factory trawlers replaced smaller trawlers. From 1964 to the mid-1970s, the fishing power of these fleets created a pattern of overfishing one species before shifting to another species. This pattern was reflected in a progression of increasing catch, followed by steep declines as abundance fell off, followed by another increase in catch as the fleet targeted another species or new fishing grounds. With the decline of catches in the Bering Sea, the fleet moved to new areas, including the GOA.

In the early 1960s, the U.S. had fisheries authority only to 3 miles and those waters were closed to all foreign fishing beginning in 1964. The U.S. thus had little leverage to restrict the large offshore Japanese and Soviet operations during their initial build-up. Fisheries research and information exchange were conducted initially with Japan and Canada under the auspices of the International North Pacific Fisheries Commission (INPFC), but it focused mainly on salmon interception issues beginning with its first organizational meeting in 1954. The Japanese provided some catch data, but the Soviets, fishing on five-year plans, provided very little information on their harvests.

The U.S. fisheries extended their jurisdiction from 3 to 12 miles on October 4, 1966 (P.L. 89-658). It provided for continued foreign fishing in the 9-mile contiguous zone, but significantly increased U.S. leverage in controlling those fisheries. For example, INPFC first considered joint studies of groundfish (other than halibut) such as Pacific ocean perch and sablefish in 1967-1971. It produced no joint conservation recommendations for either species even though it was well recognized that both stocks were in jeopardy. The INPFC and the U.S.- Canada International Pacific Halibut Commission began a joint monitoring program for halibut bycatch in Japanese trawlers in the eastern Bering Sea in 1972.

U.S.-foreign bilateral agreements were the main mechanism for managing the foreign fisheries. Bilaterals were negotiated in protracted sessions, beginning in 1967 with Japan and the USSR (there was a king crab bilateral with the Soviets in 1965). The first one was negotiated for groundfish with the Soviets in February 1967. The early bilaterals focused on protecting domestic crab, halibut and shrimp fisheries from gear conflicts and grounds preemption by foreign trawlers, and protecting fur seal populations in the Pribilof Islands.

3.4.2 Commercial Fisheries From the 1970s to the Present

In the early 1970s, foreign access to U.S. fishing grounds within the 12-nautical mile limit was controlled through bilateral agreements with Japan, Poland, the USSR, Taiwan, and the Republic of Korea. These agreements established time-area restrictions, limits on the amounts of commercial species that could be harvested, and regulations restricting foreign fleets from targeting certain species. The first closures were imposed to reduce the foreign catch of adult and juvenile Pacific halibut. In 1973, when major groundfish stocks began to seriously decline, catch quotas were negotiated between the U.S. and the principal foreign fishing nations.

Despite these restrictions, foreign catch levels remained high. By 1976, foreign fleets had overfished several groundfish stocks including yellowfin sole (Pruter 1976) and Pacific ocean perch, and had dramatically reduced the catch per unit of effort for sablefish and walleye pollock. For example, between 1968 and 1973, fishing effort for walleye pollock had increased almost four times while annual catch-per-unit-effort had declined by 50% and the fishery was increasingly dependent on small, young fish. These high catch levels contributed to the decline of other, commercially-important species like Pacific halibut (Larkins 1980).

Groundfish management was addressed beginning in 1972-1973. By then, foreign operations had depressed stocks off Alaska. Catches of yellowfin sole in the eastern Bering Sea, for example, had fallen sharply following very large removals by Japan and the Soviet Union. Pacific ocean perch stocks were decimated. Pollock catches were increasing rapidly, and were thought likely to follow the same pattern as perch and flatfish.

In 1973-1974, catch quotas were placed on EBS pollock and flatfish. Additionally, a complex array of closures was established mainly to protect U.S. fisheries for crab and halibut. The catch quotas represented the average catches of the previous 3-4 years and were an attempt to put the fisheries on hold so the stocks could be evaluated. Unfortunately, each country was responsible for monitoring its catch quotas, the only internationally acceptable arrangement at the time. The final round of negotiations on bilaterals before the Act was passed occurred in late 1974 with Japan and in mid-1975 with the USSR. The U.S. had negotiated an agreement with ROK in 1972, effective through 1977, and with Poland in 1975.

3.4.2.1 Preliminary Fishery Management Plans (PFMPs)

Following the implementation of the FCMA on March 1, 1977, foreign fishing could be conducted in the new 200 nautical mile Fishery Conservation Zone (later changed to Exclusive Economic Zone or EEZ) only pursuant to an international treaty or a governing international fishery agreement. Governing agreements were completed with Taiwan and the USSR in 1976 and with Japan, ROK and Poland in 1977. While these agreements provided foreign fleets access to the EEZ, these fleets had to fish under the rules of PFMP that applied only to foreign fisheries.

Foreign fisheries off Alaska were managed under four PFMPs: (1) trawl fisheries and herring gillnet fishery of the eastern Bering Sea and Northeast Pacific; (2) trawl fishery of the GOA; (3) sablefish fishery of the eastern Bering Sea and Northeastern Pacific; and, (4) snail fishery of the eastern Bering Sea. The latter fishery was small fishery conducted by 21 Japanese vessels that longlined with pots along the shelf edge of the Bering Sea northwest of the Pribilof Islands, harvesting about 3,000 mt of edible meats in the mid-1970s. Snails were later incorporated as an "unallocated species" in the BSAI groundfish plan published in 1981.

The PFMPs recognized that the fisheries could adversely affect marine mammals through (1) direct impacts from trawl netting, plastic wrapping bands and other debris around their necks or bodies; and (2) indirect impacts of the fisheries competing for some of the same species of fish and shellfish used as food by the northern fur seal and other marine mammals. Nevertheless, the PFMPs did not contain measures to reduce potential impacts of the fisheries on marine mammals and seabirds, except for restrictions on operating near the Pribilof Islands.

In summary, the PFMPs continued and enhanced provisions of the various bilateral agreements. In many respects, the PFMPs established the fundamental philosophy in managing the fisheries over future years as it transitioned to a completely domestic fishery in the late 1980s. The PFMPs set harvest limits for the main target species and fishing ceased when those limits were reached. The PFMPs required the fishermen to report catch and support observers. The PFMPs protected species other than groundfish using time-area closures and prohibiting retention of species such as salmon, halibut, crab, and shrimp that were important target species for domestic fisheries. The PFMPs implemented time-area closures to protect domestic fishermen from grounds preemption and gear conflicts caused by mobile foreign trawl gear.

3.4.2.2 BSAI Fishery Management Plan (FMP)

In August 1981, the NPFMC finalized an FMP for groundfish fisheries in the BSAI. The FMP was implemented with the 1982 fisheries. The FMP carried forward most of the management measures from the PFMPs. Optimal yields were set for each of the main species and species complexes and fisheries were closed when the optimal yield was reached. The concept of a set-aside or reserve was introduced to provide allocations to individual fisheries in-season. In the BSAI, 5% or 500 mt of each species was set aside, whichever was greater, and optimal yields were distributed by management area.

The 1981 FMP specifically focused on rebuilding depleted groundfish stocks. The FMP managed groundfish as a species complex, because populations of some species of groundfish will increase in response to decreases in populations of other species in the complex. The biomass of pollock in the eastern Bering Sea was estimated at 8.24 million mt (the most abundant). In the Aleutian Islands, the most abundant biomass consisted of Pacific ocean perch, pollock, and Atka mackerel. The FMP also emphasized protecting prohibited species and the associated domestic fisheries. The FMP contained a ban on retaining halibut in trawls and expanded time-area closures. Restrictions on bottom trawls were applied to the foreign fisheries and there were depth restrictions on foreign longline fishing for Pacific cod in the Winter Halibut Savings Area in the eastern Bering Sea. Except for a prohibition against retaining prohibited species, the FMP placed no restrictions on domestic fishermen in the Bering Sea.

Since 1981, the groundfish catch from the BSAI has ranged from a low of 1,294,132 mt (1999) to a high of 1,996,467 mt (1992). In 1988, the MSY had been increased to 3.4 million mt. This revised estimate, combined with increased domestic use of the resource, resulted in pressure to increase the 2 million metric ton cap to allow foreign and joint-venture fisheries to continue. In 1988, and for several years thereafter, fishermen asked the NPFMC to increase the 2 million mt cap on optimal yield in the BSAI. The NPFMC rejected these proposals because of uncertainties in the rate of removal of pollock from waters immediately outside of the fishery (e.g., in international waters); the amount of bycatch that would result; and the reliability of scientific methodologies at that time for determining allowable biological catch. For the 2000 fisheries, the NPFMC adopted an ABC of 2,260,113 mt for the BSAI. In 2000, the NPFMC set the TAC for BSAI groundfish fishery at 2 million mt.

Since 1981, the NPFMC has amended the FMP many times, primarily to protect target species, protect prohibited species, control bycatch, balance the social and economic benefits of the fishery, and increase the involvement of the domestic fleet in the groundfish fisheries. The NPFMC achieved this last objective in 1987, when groundfish fisheries in the BSAI became totally domestic (although joint ventures operated in the BSAI until 1990).

The NPFMC has taken numerous actions to protect prohibited species – mostly red king crab, tanner crab halibut, and salmon – although other species benefitted from these closures. Between 1986 and 1990, the NPFMC closed areas in the eastern Bering Sea (one area around the Pribilof Islands and two areas in Bristol Bay) to protect king crab from domestic trawlers. The Pribilof Islands Conservation Area, Red King Crab Savings Area in Bristol Bay, and a Nearshore Bristol Bay Closure Area, Bristol Bay Winter Halibut Savings Area, Bristol Bay Pot Savings Area, and three Herring Savings Areas (two summer and one winter) that are closed to trawling and scallop dredging to protect king crab and bottom habitat. The NPFMC later established Chum Salmon Savings Areas that were designed to reduce the amount of chum salmon taken as bycatch in trawl fisheries. Together, these areas close about 80,000 square nautical miles to trawling and scallop dredging.

In 1984 the NPFMC began to produce annual resource assessment documents that contained complete descriptions of each stock and its current condition. These documents set the example and standard for SAFE documents that were later required of all regional fishery management councils in the U.S. In 1990, the NPFMC established a comprehensive observer program (paid by industry) that would verify catch levels and monitor bycatch. The NPFMC required 100% observer coverage on all vessels over 125 ft and 30% coverage on those between 60 and 125 ft.

Since the late 1980s, the NPFMC has taken numerous actions to protect habitat, seabirds, and marine mammals. In 1988, the NPFMC approved a habitat policy and established a habitat committee to review permit requests that might impact fish habitat. In 1999, the NPFMC amended FMPs to include essential fish habitat (Amendment 55 to the FMP for the Groundfish Fishery of the BSAI Area and Amendment 8 to the FMP for the Commercial King and Tanner Crab Fisheries in the BSAI).

Since 1981, the groundfish catch from the BSAI has ranged from a low of 1,294,132 mt in 1999 to a high of 1,996,467 mt in 1992. For the 2000 fisheries, the NPFMC adopted a total allowable biological catch level of 2,260,113 mt for the BSAI. In 2000, the NPFMC set the TAC for BSAI groundfish fishery at 2 million mt.

In the 1980s, foreign fleets fishing in the U.S. EEZ were replaced by joint venture fisheries. By 1988, the U.S. fleet was catching the walleye pollock in the eastern Bering Sea and delivering it to foreign vessels through joint-venture fisheries that were set up after the U.S. declared the 200-mile EEZ (Bakkala 1993). By 1995, the groundfish fleet was comprised of 1,545 vessels including 1,159 vessels fishing with hook and line gear, 263 with pots, and 264 with trawls, with some of the vessels using more than one gear type. Of the total number of vessels, about 120 were catcher processors. The groundfish fleet came mainly from communities in Alaska, Washington, and Oregon. Their total groundfish harvest in 1995 was approximately 2.1 million mt, with 90% coming from the BSAI. The overall catch was 65% pollock, 15% Pacific cod, 12% flatfish, 4% Atka mackerel, 2% rockfish, 1% sablefish, and lesser amounts of other species.

3.4.3 Principal Groundfish Fish Species in BSAI

In the following sections, the walleye pollock (*Theragra chalcogramma)* (hereafter referred to as pollock) life-history and the commercial fishery are described. It is a principal target groundfish species of a fishery that is found in the BSAI and that may interact with northern fur seals. Information presented includes a brief description of life history, trophic interactions (particularly as related to pinnipeds including northern fur seals), and the fishery.

3.4.3.1 Walleye Pollock

Pollock supports the largest fishery in Alaskan waters. In the BSAI, pollock comprise 75–80 percent of the total annual catch. In the GOA, pollock constitute 25–50 percent of the catch. Fisheries management has restricted pollock to be harvested with pelagic trawl gear to minimize the potential interaction with other groundfish species and to reduce the magnitude of bottom disturbance.

The directed fishery for BSAI pollock is conducted by catcher-processors and catcher vessels using pelagic and bottom trawl gear. The season has traditionally been broken into two parts, a roe season during early winter, and a surimi (imitation crab) and filet season during the second half of the year. Currently, to minimize the potential indirect interaction with Steller sea lions, the seasons have been managed to occur over broader areas and over longer seasons.

BSAI pollock are also caught as bycatch in other directed fisheries, but because they occur primarily in well-defined aggregations, the impact of this bycatch is typically minimal (Iannelli et al. 2000).

Since 1998 measures have been implemented to reduce the potential for adverse modification of the pollock fishery on Steller sea lion critical habitat. The BSAI fishery was also subject to reductions in total catch and changes in catch distribution. The reductions resulted from closures of the Aleutian Islands region to pollock fishing. The closure of the Aleutian Islands region reduced the amount of pollock caught in the area from 22,000 mt in 1998 to zero metric tons in 1999 and 2000 (Ianelli *et al.* 2000).

However, one area around Dalnoi Point, St. George Island, experienced significant increases in pollock catch within 10 nm of the haulout during 2001 and 2002. The amount of pollock caught in 1999 inside of 20 nm from St. George Island increased from 3,736 mt to over 30, 239 mt caught within 20 nm of the point in 2002. This amount of pollock represented over 2 percent of the entire TAC for the Bering Sea being caught within 20 miles of one Steller sea lion haulout and the fur seal rookeries on St. George Island, and an order of magnitude increase in the amount of pollock taken from this one location. This increase is one of the principal reasons for the conditionally adverse cumulative effect determination of the commercial fishery on fur seals.

Many other groundfish species are targeted in the Alaska groundfish fishery. These species are not described herein but found in the following documents: Environmental Assessment for Essential Fish Habitat (NPFMC 1999a); Essential Fish Habitat Assessment Report for the Groundfish Resources of the Bering Sea and Aleutian Islands (BSAI) Region (NPFMC 1998a); Essential Fish Habitat Assessment Report for the Groundfish Resources of the Gulf of Alaska (GOA) Region (NPFMC 1998b); the year 2000 Stock Assessment and Fishery Evaluation Reports (SAFE Report) for the Groundfish Resources of the BSAI and GOA Regions (NPFMC 2000a, 2000b).

(i) Description and Life History in the BSAI

Pollock is the most abundant fish species within the EBS. It supports the largest fishery in Alaskan waters. Pollock is also known to be a major prey item of Steller sea lions and northern fur seals. Concerns regarding the possible adverse effects of the fishery for pollock and other groundfish species on sea lions has prompted the development of this SEIS. Modification of the spatial and temporal distribution of the pollock fishery are central to this SEIS. For this reason pollock are covered in some detail here. More detailed information regarding the pollock and the pollock fishery is available in the 2000 SAFE Reports (NPFMC 2000c, 2000d).

It is widely distributed throughout the North Pacific Ocean in temperate and subarctic waters (Wolotira *et al.* 1993). Pollock is a semi-demersal schooling fish, which becomes increasingly demersal with age. Approximately 50 percent of female pollock reach maturity at age four, at a length of approximately 40 cm. Pollock spawning is pelagic and takes place in the early spring on the outer continental shelf. In the EBS, the largest concentrations occur in the southeast, north of Unimak Pass. Pollock are comparatively short-lived, with a fairly high natural mortality rate estimated at 0.3 (Hollowed *et al.* 1997; Wespestad and Terry 1984) and maximum recorded age of around 22 years.

Although stock structure of Bering Sea pollock is not well defined (Wespestad 1993), three pollock stocks are recognized in the BSAI for management purposes: EBS, Aleutian Islands, and Aleutian Basin. Pollock in the GOA are thought to be a single stock (Alton and Megrey 1986) originating from springtime spawning in Shelikof Strait (Brodeur and Wilson 1996).

(ii) Trophic Interactions

The diet of pollock in the EBS has been studied extensively (Dwyer 1984; Lang and Livingston 1996; Livingston 1991a; Livingston and DeReynier 1996; Livingston *et al.* 1993). Juvenile pollock are pelagic and feed primarily on copepods and euphausiids. As they age, pollock become increasingly piscivorous and can be highly cannibalistic. Juvenile pollock is known to be the dominant fish prey of adult pollock in the EBS. Other fish consumed by pollock include juveniles of Pacific herring, Pacific cod, arrowtooth flounder, flathead sole, rock sole, yellowfin sole, Greenland turbot, Pacific halibut, and Alaska plaice. On the shelf area, the contribution of these other fish prey to the diet of pollock tends to be very low (i.e., usually less than 2 percent by weight of the diet; (Livingston 1991a; Livingston and DeReynier 1996; Livingston *et al.* 1993). However, in the deeper slope waters, deep-sea fish (myctophids and bathylagids) are a relatively important diet component (12 percent by weight), along with euphausiids, pollock, pandalid shrimp, and squid (Lang and Livingston 1996).

Various studies have modeled pollock cannibalism and other sources of predation, particularly in the EBS (Dwyer 1984; Honkalehto 1989; Knechtel and Bledsoe 1981, 1983; Laevastu and Larkins 1981; Livingston 1991b, 1993, 1994; Livingston *et al.* 1993; Livingston and DeRenyier 1996; Wespestad and Dawson 1992). The modeling efforts, and the extent and dynamics of pollock cannibalism are described in detail in the Alaska Groundfish Fishery Draft PSEIS (NMFS 2001).

While cannibalism is the significant source of juvenile mortality in the EBS, several other groundfish predators are also important consumers. Other juvenile pollock predators include Greenland turbot, arrowtooth flounder, Pacific cod, halibut, and flathead sole (Livingston 1991b; Livingston and DeReynier 1996; Livingston *et al.* 1993). These species are some of the more abundant groundfish in the EBS, and pollock constitute a large proportion of their diets. Other less abundant species that consume pollock include Alaska skate, sablefish, Pacific sandfish, various sculpins, and small-mouthed flounders such as yellowfin sole and rock sole (Livingston 1989; Livingston et al. 1993; Livingston and DeReynier 1996). Age-0 and age-1 pollock are the targets of most of these predators, with the exception of Pacific cod, halibut, and Alaska skate, which may consume pollock ranging in age from age-0 to greater than age-6.

Pollock is a major prey item for pinnipeds in the BSAI and EBS including northern fur seals and Steller sea lions (Merrick and Calkins 1996; Pitcher 1980a, 1980b, 1981). In the Bering Sea, the preponderance of available data indicates that pollock is a dominant prey species for northern fur seals when feeding on the shelf during summer (Sinclair et al. 1997 and 1994). The pollock consumed by fur seals are primarily age 0 and age 1 fish. Older age groups of pollock may appear in the diet, when young pollock are less abundant (Sinclair et al. 1997). Pollock has been noted as a prey item for other pinnipeds, including harbor seals, spotted seals, and ribbon seals. Harbor seals tend to have a variable diet and the pollock component varies with abundance. Spotted seals and ribbon seals feed on pollock in the winter and spring in the areas of drifting ice and pollock are their most common prey during these seasons (Lowry et al. 1997). Fin whales, minke whales, and humpback whales in the EBS are also known to be pollock predators. Stomach samples from the whale species have been very limited, so the importance of pollock in their diets has not been well-defined (Kajimura and Fowler 1984).

In the EBS, age 0 and age 1 pollock are variably the dominant component in the diets of northern fulmars, black-legged kittiwakes, common murres, and thick-billed murres. Red-legged kittiwakes also consume pollock but tend to rely more heavily on myctophids (Hunt et al. 1981; Kajimura and Fowler 1984; Springer et al. 1986). These species are the dominant avifauna of the eastern Bering Sea (Kajimura and Fowler 1984; Shuntov 1993). Fluctuations in chick production by kittiwakes have been linked to the availability of fatty fishes, such as myctophids, capelin, and Pacific sand lance (Hunt et al. 1995). Changes in the availability of prey, including pollock, to surface-feeding seabirds may be due to changes in sea surface temperatures and the locations of oceanographic features such as fronts, which could influence the horizontal or vertical distribution of prey (Decker et al. 1995; Springer 1992).

(iii) The Pollock Fishery in the Aleutian Basin

The pollock fishery in the Aleutian Basin (the Donut Hole) developed rapidly in the 1980s. The uncontrolled growth of this fishery spurred worries about overfishing and the effects of Aleutian Basin catches on the pollock populations of the EBS. The donut hole fishery was being conducted by trawl vessels from Japan, the Republic of Korea, Poland, the People's Republic of China, and the former Soviet Union. Catch data submitted by these countries indicated that annual harvests in the donut hole rose to about 1.5 million mt from the mid-1980s to 1989. Largely due to drastic declines in catch and catch per unit effort from 1990, leading to a total catch of under 300,000 mt in 1991 and under 11,000 mt in 1992, the governments agreed to suspend fishing in the area for 1993 and 1994. The results of monitoring in the region during this 2-year hiatus produced no evidence that the stock recovered.

As a result, and after three years of negotiations, the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea was signed on December 8, 1995. The major principles of this convention included: no fishing in the donut hole unless the biomass of the Aleutian Basin exceeds a threshold of 1.67 million mt; allocation procedures; 100 percent observer and satellite transmitter coverage; and prior notification of entry into the donut hole and of transshipment activities.

From 1997 to the present, the Parties to the Convention established the Allowable Harvest Level of pollock in the Central Bering Sea at zero, although the Parties agreed that there were insufficient data to directly estimate the pollock biomass in the Aleutian Basin. Nevertheless, in 1998 the best estimate placed this biomass at 342,000 mt, which was about 50 percent lower than the 1997 estimate and the lowest biomass on record for this area. In 1998, the biomass in the entire Aleutian Basin was estimated at 572,000 mt; estimates for 1999 and 2000 showed no increase in biomass. In addition, all trial fishing results in 1997 showed little or no pollock in the Central Bering Sea.

3.4.4 American Fisheries Act (AFA)

On October 21, 1998, the President signed into law the AFA. The AFA was significant in that it established a new allocation scheme for BSAI pollock, provided for buyout and scrapping of nine BSAI pollock catcher/processors, listed by name or provide qualifying criteria for non-Community Development Quota (CDQ) Program BSAI pollock participants, increased observer coverage and scale requirements for BSAI catcher/processors, established limits on BSAI pollock fishery cooperatives in the non-CDQ sectors, required individual allocations of BSAI pollock TAC to inshore catcher-vessel cooperatives, required restrictions on vessels benefitting from the AFA to protect vessels not participating in the AFA, and established excessive share caps.

Since the passage of the AFA in October 1998, the Council and NMFS have developed extensive management measures to implement the requirements of the AFA. While some of the resulting regulations were in place for the 1999 fisheries, the majority of the regulations were implemented in 2000 through emergency regulations. NMFS is currently in the process of preparing proposed rules including those regulations, although it is likely that these regulations will be implemented by emergency regulations again in 2000. For example, the AFA emergency regulations require the allocation of pollock TAC among fishery sectors (and within sectors where necessary), among fishery areas, and among fishing seasons. The rule also establishes harvest restrictions or "sideboards" on the participation of unrestricted AFA catcher/processors in other BSAI groundfish fisheries and completely prohibits AFA catcher/processors fishing in the GOA.

The effects of the AFA on the BSAI groundfish fisheries are largely related to ownership restrictions and restrictions on the number of vessels in the fishing fleet, allocation of pollock among the four sectors in Bering Sea, improving observer coverage and assessment of tons caught, restrictions in other fisheries (including fisheries in the GOA) of vessels benefitting from the AFA, and requirements for formation of cooperatives within sectors. These allocations have altered the nature of the pollock fishery by eliminating the race for fish, and allowing for better temporal dispersion of catch. The formation of cooperatives may also facilitate spatial dispersion of the catch to the extent that vessels can be more deliberative about where and when they fish to maximize profit. At present, no evidence suggests that the implementation of the AFA will increase the likelihood of operational or biological interactions between the BSAI groundfish fisheries.

In total, the AFA deals with rules and limits for participation in the BSAI pollock fishery, and allocation of the pollock among the participants. In general, issues related to allocation of TAC are resolved or managed in the NPFMC arena, where the industry and the public at large have an opportunity to participate. The AFA should indirectly benefit Steller sea lions by reducing the fishing power of the catcher/processor sector of the BSAI pollock fleet, reducing the rate at which pollock can be taken, increasing the temporal dispersion of the fishery, and thereby reducing the probability of localized depletion of pollock. The AFA also should increase the amount and accuracy of fisheries data from the catcher/processor sector. Such data is essential to assess the pollock stock, fishing practices, and potential effects on Steller sea lions.

3.4.5 Alaska State Managed Fisheries

The Alaska Department of Fish and Game (ADFG) oversees BSAI crab, salmon, and some rockfish fisheries in Federal waters (EEZ) under FMPs adopted by the North Pacific Fishery Management Council (NPFMC). ADFG coordinates their fishery openings and in-season adjustments with Federal fisheries. For example, when groundfish fishing is open in Federal waters, current state regulations allow fishing to occur in state waters in what is referred to as the “parallel” fishery. However, the State retains regulatory jurisdiction over fisheries within State waters.

State fisheries are managed by a highly localized system of regional offices scattered throughout the state. Generally, each region has separate state FMPs and is responsible for producing management reports, issuing harvest limits, and providing in-season management of fisheries. This is in contrast to the Federal fishery which is composed of very large management units with relatively large harvest limits. The state’s system allows for micro-management down to the bay or stream level. Closures are often issued over VHF radio, and fishery openings can be as short as 20 minutes. Whereas the Federal fishery uses summer and winter surveys combined with stock assessment models to assess biomass and catch limits, the state employs a variety of methods of determining catch and biomass including stock recruitment models, aerial surveys, escapement goals, historical fishery harvest performance, and others.

3.4.5.1 State-managed Crab Fisheries

The BSAI crab fisheries are the most significant of the state-managed fisheries to the Pribilof Islands. In 1930, Japan began commercial harvests of king crab, although final development of the fishery was delayed by World War II. U.S. fleets began to harvest king crab in 1947 followed by a resumption of the Japanese fishery for king crab in 1953. In 1959, Russian fleets entered the king crab fishery. By 1964, the catch of king crab peaked with 9,000,000 crabs, then declined to 3,500,000 in 1970 when Russia ended their harvest. The Japanese terminated their fishery in 1974. By 1975, the entire harvest of 9,000,000 was taken by U.S. fishermen (Lowry et al. 1982).

Prior to 1964, EBS Sea tanner crab were harvested incidental to the king crab fishery. Landings peaked at over 24 million crabs in 1969 and 1970. Russian terminated their involvement in the fishery in 1971. By 1976, the harvest of 18 million tanner crabs was divided between the U.S. and Japanese fishermen.

The state currently manages all crab fisheries in the BSAI and GOA, although State management in the BSAI is subject to a federal FMP for the crab fishery. King (brown, red, blue), Dungeness, and Tanner crabs are taken by hand-picking, shovel, trawl, pot, and dredge gear. Crab fisheries began in the early 1960s when the stocks were abundant, then declined in the mid-1980s into the 1990s. State crab fisheries occur in Bristol Bay, Dutch Harbor, Alaska Peninsula, Kodiak, Cook Inlet, Adak and W. Aleutian Islands, and Prince William Sound. Crab fisheries primarily occur during the winter season. Over the past ten years, the industry has focused on Alaska snow crab (*C. opilio*), and the catch has exceeded historical levels of king crab harvests from the late 1970s.

Most westward crab stocks were not healthy in 1999. All major red king crab stocks, except those in Norton Sound, Bristol Bay and the Pribilof Islands, were very low in abundance and continued to decline. Consequently, these fisheries have been closed for sometime. Bering Sea Tanner crab has been declared overfished and closed since 1997. St. Matthew and Pribilof Islands blue king crab fisheries have been closed since 1999 due to low stock abundance. The Bering Sea snow crab harvest limit was drastically reduced in 1999 because of stock decline.

Crab species harvested in 1999 included red king, blue king, golden king, scarlet king, snow, Dungeness, and Korean hair crab. Approximately 96,302 t of crab was landed with Bering Sea snow crab dominating the total harvest. The 1999 harvest consisted of snow crab 91.5%, red king crab 5.6%, golden king crab 2.5%, Dungeness crab 0.3%, Korean hair crab 0.1%, and scarlet king crab <0.0001%. Prices were high for Bristol Bay and AI king crabs due to stable Asian economies, increased domestic demand for crab, decreased Russian production, and closures of Pribilof Islands and St. Matthew Island king crab fisheries.

3.5 Traditional Knowledge of the Bering Sea

Coastal Alaska Natives have a long history of living closely with the marine resources of the Bering Sea and GOA. This knowledge has been passed from generation to generation within Alaska Native communities, but has traditionally not been integrated with Western science. As an attempt to bridge this gap, The Bering Sea Coalition and the Whirling Rainbow Center held the first International Indigenous People's Summit Conference on the Bering Sea, March 16–20, 1999, entitled "Wisdom Keeper's of the North: Vision, Healing, and Stewardship for the Bering Sea"

(Bering Sea Coalition 1999). The following principles were intended to be used as a framework for discussions:

- Be rooted in process-oriented Alaska Native traditional gathering models rather than the goal-oriented Western convention model.

- Provide coastal communities with a widely representative forum to review current research on the Bering Sea ecosystem and its components.

- Consider models of native environmental management and community development to strengthen their collective stewardship role.

- Create an opportunity for the traditional knowledge and wisdom of Bering Sea native peoples to be heard beyond the confines of the villages.

- Promote the utilization of traditional knowledge and wisdom of indigenous peoples in scientific, resource management, and responsible use policies affecting the Bering Sea.

At this meeting, many observations were made by Alaska natives and others on the state of the Bering Sea ecosystem. The following observations were made during the conference. The comments presented are those most closely related to environmental changes that attendees to the conference have observed:

- ". . . the cyclical nature of things."

- "The ice on the Bering Sea used to be three to four feet thick, and now it is only six to eight inches thick."

- "The weather is changing and is much warmer than in the past."

- "The number of fish has decreased."

- "In one area, beaver are moving much farther up the streams and constructing dams, blocking off the movement of fish."

- "There has been an increase in the presence of worms and king salmon."

- "Dumping of bycatch into the sea is a shocking abuse of cultural mores. We never waste anything. We take for food and we always share. When you hunt, only get what you need to eat."

- "Herbs and wild celery are brown from pollution in the atmosphere."

- "Salmon have spots on them, and their flesh is different."

- "Our fish are coming, but are not as good-looking as they used to be. Our seals are thinner and the fish have gashes on them from the trawl nets."

- "The bird eggs are fragile now. You touch them and they break. Something is happening to them that is not good, and we need help to find out what it is."

- "Sheefish is a beautiful fish and is being ruined now, too. Why are they less today?"

- "Cold weather has something to do with the survival of some sea mammals. Now the tides are changing because the climate is warming up, and that has something to do with animal declines because the ice is thinning. The animals need thick ice."

- "Sports fishermen and trawlers throw fish away that they catch. This wanton use of our animals and fish is part of the reason for their decline."

- "I eat the sea lion, but we can't eat its liver because it has mercury."

- "We are taking too much from Mother Earth and the animals without giving anything back. The greed is ruining us."

- "Changes have occurred in the whale population, migration, and appearance."

Another source of traditional knowledge is historical records of changes seen in the Bering Sea and GOA. The following notes were taken from *Notes from the Unalashka District* by Russian Orthodox priest Ivan Veniaminov (notes provided by Merrill 2000):

- Significant decreases in cod, salmon, and other marine fish abundance beginning in mid 1820s lasting through mid 1830s.

- Significant decreases in sea otter, sea lion, and seal populations during the mid 1820s.

- In the early 1800s over one thousand sea otters were taken in this district. Now (mid to late 1830s) only 70 to 150 otters are taken and there was a time (1826) that the catch was only 15 otters.

- On Unga Island, anywhere from 30 to 200 head of caribou were taken at one time; now only five caribou are usually taken.

- In the spring, they used to catch several hundred cod daily from baidaras (kayaks), but in the years 1825 and 1826 there was not a single cod fish taken. Also, seasonal migrating fish (e.g., salmon and Dolly Varden) used to be taken in the hundreds of thousands. Now they scarcely catch twenty thousand fish.

- Sea otters are now found only on the South side, close to shore, and in very small numbers.

- Sea lions are found in even smaller numbers, in a single locality, not far from Usov Bay, and not a single fur seal is to be found anywhere.

Additional, more recent comments listed by Merrill include the following:

- Cod stocks decreased in the mid 1910s and many cod fishing stations closed.

- Sudden decreases in marine fish and mammal species occurred in the late 1940s and mid 1950s. These observations seem to reflect more recent scientific findings linking fish abundance to climatological conditions.

Additional local knowledge is provided by fishermen and others directly in contact with the fisheries and marine ecosystems in which they work. They tend to notice changes in fisheries and the environment on a qualitative level as they are impacted by those changes. Their insights are provided below. The following information was provided by Vining (1995).

- The GOA underwent a dramatic change in the 1970s, according to coastal residents. Species composition switched from shellfish to finfish, marine temperatures warmed, and larval and juvenile fish began “contaminating” the tows of Kodiak area shrimp fishermen. The shrimp fishermen discovered another problem when they found a “green slime” plugging their nets, requiring a cleaning every second tow. Also, Steller sea lions began tearing up trawl nets. These two problems lasted only a few years.

- There has been a decline of forage fish, simultaneous to the decline of the shrimp population. By the 1980s, the shrimp and king crab populations were below threshold levels and the fisheries were closed. Capelin, which was traditionally observed spawning on beaches in the Kodiak area, has rarely been observed on beaches since then.

- Starting in October 1993, the Kodiak trawl fleet had great difficulty locating fishable concentrations of rock sole. The lack of rock sole persisted through at least the first three quarters of 1994. Dover sole also proved difficult to find in fishable concentrations. New groups of 30 cm halibut were reported on the grounds and halibut bycatch rates in 1994 were much greater than those in 1993.

The following information was provided by Vining (1998).

- Sea surface temperatures in the Bering Sea were well above normal in the summer of 1997.

- A massive bloom of coccolithophores occurred in the EBS July through August 1997, which may have altered the trophic dynamics of the Bering Sea food web. For instance, the returns of pink salmon in Alaska were much lower than expected for all regions of the state following this bloom. The sockeye salmon returns were lower than forecast and cnidarian (jellyfish) species were highly abundant.

- There were several observations of rare and exotic species in 1997. These include a right whale and her calf in the Bering Sea, an ocean sunfish, a pelagic armourhead, and a jack were observed off Kodiak Island. Greenland turbot and a large shark (possibly a great white) were taken in set nets in the Shumagin Islands [right whales have been observed each since 1996].

- Two stone spearheads were recovered from a bowhead whale taken for subsistence purposes off Barrow by Ben Ahmaogak's crew. Because steel replaced stone at the turn of the century, the harpoon blades were estimated to be at least 100 and, perhaps, 130 years old, and indicate that the whales may live longer than previously thought (Weintraub 1999).

The following information was provided by Vining (1999).

- In 1998, there were several warm-water species observed in the Gulf of Alaska along with other stray fish, marine mammals, and seabirds. Several Pacific barracuda (*Sphyraena argentea*) were sighted in July; two were caught in the Valdez Arm of Prince William Sound, one from Old Harbor on Kodiak Island, and several were caught near Haines. Ocean sunfish (*Mola mola*) were seen in Resurrection Bay in mid-August and near Ketchikan from July through September. Chub mackerel (*Scomber japonicus*) were also found near Ketchikan and, although these two species are not uncommon in southeast Alaska, the quantities documented for both were unusual. Similarly, Pacific sleeper sharks were caught (and released) in higher than normal levels in Cook Inlet, while salmon sharks were caught in fairly large numbers off Afognak Island (Kevin Brennan, ADF&G - personal communication).

- The incidence of spiny dogfish has dramatically increased in the Kodiak area and in Prince William Sound (Bill Bechtol and Dave Jackson, ADF&G - personal communication). In 1998, this species' occurrence in collection tows increased by more than 40 percent. This increase has also been observed in the International Pacific Halibut Commission's Gulf of Alaska halibut longline surveys (Lee Hulbert, NMFS - personal communication), from NMFS 2001.

- Several individual species were seen at some unusual times and/or places including a Pacific white-sided dolphin in a cove near Haines on a regular basis, and a Northern right whale just off Kodiak Island.

- As for birds in the Gulf of Alaska, a gray-tailed tattler *(Heteroscelus brevipes)* was spotted just south of the Kenai Peninsula, which is unusual in this area. Also, a mallard (*Anas platyrhynchos)* was spotted several miles offshore when it landed near a halibut research vessel. Mallards are common to this area, but not so far offshore. Lastly, common murre *(Uria aalge)* die-offs were reported in Cook Inlet, Kodiak, east Aleutians, Seward, and the Bering Sea.

- Three northern elephant seals were spotted near and around Unalaska during late June and early July, whereas they are usually found farther offshore and at a different time of year. There was a poor return of sockeye salmon as well as chinook salmon to Bristol Bay.

- Both the Bering Sea and the Gulf of Alaska had warmer-than-usual temperatures (Hare and Mantua 2000), though not as great as was observed in 1997.

3.6 Social, Economic and Cultural Environment

3.6.1 Community Profiles in the BSAI and Pribilof Islands

The population structure of the communities and regions in the BSAI vary considerably. Within the relevant coastal Alaskan communities there is a relationship between the percentage of Alaska Native population and commercial fisheries development. Specifically, communities that have developed as large commercial fishing communities in the BSAI region have become less Native in composition over time compared to other communities in the region. There are many variables involved, but for most communities noted the relationship is quite straightforward. The fishery has also had an impact on the male-female population balance for some of the Alaskan communities that are the focus of intensive groundfish fishing or crab processing. This is due to the fact that processing workers reside within these communities for varying durations, and that this workforce is predominately male. An exception to this generalization is St. Paul, where intense processing activity takes place, but where much of the processing associated employment is found aboard mobile processors, such that the employees typically are not included in population counts. The differences in the male/female and Native/non-Native population segments are, to a degree, indicative of the type of articulation of the directly fishery-related population with the rest of the community.

3.6.1.1 Pribilof Island Communities

Table 3.2 provides ethnicity information from the 2000 census for each of eight communities in the BSAI and Pribilof Island region. As shown, these communities vary widely in their population structure. For example, Unalaska the second largest community, has the lowest Alaska Native population percentage, while St. Paul and St. George have a much higher Alaska Native population component than any of the other communities shown. Akutan, while having a relatively low Alaska Native population percentage is, however, arguably one of the "most traditional" Aleut communities. Unalaska, Adak, and Kodiak have far higher white or non-minority population percentages than the other five communities. Asian residents represent the largest population segment in Akutan, and the second largest Unalaska and Kodiak (behind whites) as well as in King Cove (behind Alaska Natives), and the third largest in Sand Point (behind Alaska Natives and whites). These communities have quite different histories with respect to the growth of the different population segments present in the community in 2000. Each is summarized briefly below. One important constant across all of these communities is that each is a minority community in the sense that minorities make up a majority of the population in each community.

The Pribilof Islands were encountered in 1786 by Russian fur traders who landed first on St. George, and originally named the larger island to the north St. Peter and St. Paul Island. Beginning in 1788, the Russian American Company relocated indentured or enslaved Aleuts from Siberia, Atka and Unalaska to the Pribilofs to hunt fur seals, and the contemporary population of the communities of St. Paul and St. George trace their ancestry to those original hunters. The island was administered by the Russian American Company until the sale and transfer of Alaska from Russia to the U.S. in 1867. In 1870, the Alaska Commercial Company was awarded a 20-year sealing lease by the U.S. government, and provided housing, food and medical care to the Aleuts in exchange for seal harvesting. In 1890, a second 20-year lease was awarded to the North American Commercial Company. The 1910 Fur Seal Act ended private leasing on the Islands and placed the community and fur seals under the U.S. Bureau of Fisheries. In 1983, Congress passed the Fur Seal Act Amendments, which ended government control of the commercial seal harvest and the effective federal domination of daily life on the island. Commercial sealing was discontinued shortly after. The local commercial halibut fishery got its start in 1981, and a crab processing plant was built several years later. Local residents hold commercial fishing permits for halibut, a few own halibut individual fishing quotas, and local boats also fish for CDQ halibut. There are onshore processing facilities on St. Paul, and crab is processed on mobile processing platforms in both St. Paul and St. George.

Information on income and employment for the Alaska communities most heavily engaged in the BSAI crab fishery are presented in Tables 3.2 and 3.3. These tables are based on 2000 U.S. Census data and they provide useful comparative information. Table 3.3 displays median household and family income. As shown, the range is large for the communities listed. For example, median family income in Unalaska is almost twice a large as the comparable figure for Akutan. This does not reflect the entire range for the Aleutian/Pribilof Islands region, however, as a couple of communities in the region without commercial crab development (Atka and Nikolski) have a lower median family income than Akutan. In 2000, Unalaska had the highest median family income in the Aleutian/Pribilof Islands region at $80,829 and Atka had the lowest at $34,375.

Table 3.4 displays data on employment and poverty information for the relevant communities for 2000. These data must be interpreted with some caution, as it is apparent that the census that generated these figures must have occurred at a time when seafood processing workers were present but idle in some of the communities. For example, Akutan with a total population of 713, is shown has having 505 unemployed persons with an unemployment rate of 78.9 percent. Given that Akutan consists of a traditional community of about 80 residents and a large seafood processing facility whose workers account for over 600 community residents, it is obvious that the census took place while seafood processing workers were present but not employed, which is not a typical situation. In contrast, the 1990 census occurred when the processing plant was operating, and only 2 out of 527 residents were unemployed, with an unemployment rate of 0.4 percent.

3.6.1.2 Housing: Group housing in St. Paul has historically been largely associated with federal employment, temporary construction projects, and seafood processing. Federal employment declined significantly prior to 1990. As shown in Table 3.5, 26 percent of the population lived in group housing in 1990, but only 4 percent did so in 2000. This sharp drop is attributable to a reduction in enumeration of fish processing employees (but whether this was due only to a decline in such activity, or at least partially to change in the timing of such activity, is not clear). It is also likely a function of a decline in "special projects" (with outside workers) as well.

Table 3.2 Ethnic composition of population, selected Bering Sea and Aleutian Islands communities, 2000.

	Unalaska		Akutan		King Cove		Sand Point		Adak		St. Paul		St. George		Kodiak	
Race/Ethnicity	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
White	1,893	44.2%	168	23.6%	119	15.0%	264	27.7%	157	49.7%	69	13.0%	12	7.9%	2,939	46.4%
African American	157	3.7%	15	2.2%	13	1.6%	14	1.5%	4	1.3%	0	0.0%	0	0.0%	44	0.7%
Native American/Alaska Native	330	7.7%	112	15.7%	370	46.7%	403	42.3%	111	35.1%	457	85.9%	140	92.1%	663	10.5%
Native Hawaiian/Other Pacific Islander	24	0.6%	2	0.3%	1	0.1%	3	0.3%	6	1.9%	3	0.1%	0	0.0%	59	0.9%
Asian	1,312	30.6%	275	38.6%	212	26.8%	221	23.2%	31	9.9%	0	0.0%	0	0.0%	2,010	31.7%
Some Other Race	399	9.3%	130	18.2%	47	5.9%	21	2.2%	0	0.0%	0	0.0%	0	0.0%	276	4.4%
Two Or More Races	168	3.9%	11	1.5%	30	3.8%	26	2.7%	7	2.2%	3	0.1%	0	0.0%	343	5.4%
Total	4,283	100%	713	100%	792	100%	952	100%	316	100%	532	100%	152	100%	6,334	100%
Hispanic[1]	551	12.9%	148	20.8%	59	7.4%	129	13.6%	16	5.1%	0	0.0%	0	0.0%	541	8.5%

Notes: N - number of individuals.
% - percentage of individuals.
[1]Hispanic is an ethnic category and may include individuals of any race and, therefore, is not included in the total as this would result in double counting.
Source: U.S. Bureau of Census.

Table 3.3 **Household income information for selected Bering Sea and Aleutian Islands crab communities, 2000.**

Community	Housing Units	Occupied Housing Unites	Vacant Housing Units	Total Households	Average Persons Per HH	Median HH Income	Family Households	Median Family Income
Unalaska	988	834	154	834	2.51	$69,539	476	$80,829
Akutan	38	34	4	34	2.21	$33,750	18	$43,125
King Cove	207	170	37	170	2.90	$45,893	117	$47,188
Sand Point	282	229	53	229	2.67	$55,417	156	$58,000
Adak	884	159	725	159	1.99	$52,727	61	$53,899
St. Paul	214	177	37	177	2.88	$50,750	123	$51,750
St. George	67	51	16	51	2.98	$57,083	42	$60,625
Kodiak	2,255	1,996	259	1,996	3.10	$55,142	1,362	$60,484

Notes: HH - household
Source: U.S. Bureau of Census.

Table 3.4 **Employment and poverty information for selected Bering Sea and Aleutian Islands crab communities, 2000**

Community	Persons Employed	Persons Unemployed	Percent Unemployment	Percent Adults Not Working	Not Seeking Employment	Percent Poverty
Unalaska	2,675	414	11.1%	27.93%	625	12.5%
Akutan	97	505	78.9%	84.84%	38	45.5%
King Cove	450	31	4.7%	31.50%	176	11.9%
Sand Point	427	190	22.8%	48.67%	215	16.0%
Adak	196	16	6.7%	16.31%	23	4.7%
St. Paul	227	40	9.1%	39.22%	143	11.9%
St. George	76	3	3.1%	21.64%	18	7.9%
Kodiak	3,053	160	3.6%	29.62%	1,170	7.4%

Source: U.S. Bureau of Census.

Table 3.5 Group quarters housing information for St. Paul, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	763	196	25.69%	567	74.31%
2000	532	22	4.13%	510	95.87%

Source: U.S. Census 1990 STF2, Census 2000 Summary File 1.

Table 3.6 provides 1990 census information on group housing and ethnicity for St. Paul. Also as shown, ethnicity varied strikingly between the group and non-group housing, with the non-group housing population being 88 percent Alaska Native and the group housing population being only 2 percent Alaska Native. Table 3.7 provides information on the age and the male/female ratio of St. Paul's population in 1990 and 2000. As shown, there was a larger male to female imbalance in 1990 than is seen in 2000. This, like the changes seen in overall population, ethnic composition of the population, and proportion of the population living in group quarters, can be attributed to the lack of a transitory or mobile labor force in 2000, which has resulted in the community having less of an "industrial" or "institutional" type of population and more of a "residential" type of community population.

St. George has yet a different population structure. As shown in Table 3.8, none of the residents of St. George lived in group quarters in 1990 or 2000. This is consistent with no commercial seafood processing taking place on shore in the community during this period

Table 3.9 provides a breakout by ethnicity for St. George's population by housing type for 1990. As shown in Table 3.10, the male to female ratio is much closer to an even distribution reflective of a typical residential population than is seen in any of the other communities profiled. Alone among the communities discussed, females outnumber males in St. George. Unlike the other communities profiled, St. George has seen virtually no commercial fisheries development onshore

Table 3.6 Ethnicity and group quarters housing information for St. Paul, 1990.

Race/Ethnicity	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	164	21.5%	99	50.5%	65	11.5%
Black	12	1.6%	12	6.1%	0	0.0%
American Indian, Eskimo, Aleut	504	66.1%	4	2.0%	500	88.2%
Asian or Pacific Islander	44	5.8%	42	21.4%	2	0.4%
Other race	39	5.1%	39	19.9%	0	0.0%
Total population	763	100.0%	196	100.0%	567	100.0%
Hispanic origin, any race	62	8.1%	59	30.1%	3	0.5%
Total minority population	605	79.3%	102	52.0%	503	88.7%
Total non-Minority population (White non-Hispanic)	158	20.7%	94	48.0%	64	11.3%

Source: U.S. Census 1990 STF2.

Table 3.7 Population composition by age and sex for St. Paul, 1990 and 2000.

	1990		2000	
	N	%	N	%
Male	478	62.6%	294	55.3%
Female	285	37.3%	238	44.7%
Total	763	100%	532	100%
Median Age	NA		31.9 years	

Notes: N - number of individuals.
NA - data not available.
% - percentage of individuals.
Source: U.S. Bureau of Census

Table 3.8 Group quarters housing information for St. George, 1990 and 2000.

Year	Total Population	Group Quarters Population		Non-Group Quarters Population	
		Number	Percent of Total Population	Number	Percent of Total Population
1990	138	0	0.0%	138	100.0%
2000	152	0	0.0%	152	100.0%

Source: U.S. Census 1990 STF2, Census 2000 Summary File 1.

Table 3.9 Ethnicity and group quarters housing information for St. George, 1990.

Race/Ethnicity	Total Population		Group Quarters Population		Non-Group Quarters Population	
	Number	Percent	Number	Percent	Number	Percent
White	7	5.1%	0	0.0%	7	5.1%
Black	0	0.0%	0	0.0%	0	0.0%
American Indian, Eskimo, Aleut	131	94.9%	0	0.0%	131	94.9%
Asian or Pacific Islander	0	0.0%	0	0.0%	0	0.0%
Other race	0	0.0%	0	0.0%	0	0.0%
Total population	138	100.0%	0	0.0%	138	100.0%
Hispanic origin, any race	0	0.0%	0	0.0%	0	0.0%
Total minority population	131	94.9%	0	0.0%	131	94.9%
Total non-minority population (White non-Hispanic)	7	5.1%	0	0.0%	7	5.1%

Source: U.S. Census 1990 STF2.

Table 3.10 Population composition by sex for St. George, 1990 and 2000.

	1990		2000	
	N	%	N	%
Male	64	46.4%	73	48.0%
Female	74	53.6%	79	52.0%
Total	138	100.0%	152	100.0%
Median Age	NA		33.0 years	

Notes: N - number of individuals.
NA - data not available.
% - percentage of individuals.
Source: U.S. Bureau of the Census.

Chapter 4 Environmental Consequences

This chapter forms a scientific and analytic baseline for comparisons across alternatives. As such, this section evaluates the probable environmental, biological, cultural, social and economic consequences of the alternatives and reviews those activities that, in addition to authorizing a harvest, may cumulatively impact northern fur seals and the environment.

Differences between direct and indirect effects are primarily linked to the time and place of impact. Direct effects are those that result from the action and occur at the same time and place. Indirect effects are those reasonably foreseeable effects that are caused by the action but that may occur later and farther from the location of the direct effects (40 CFR 1508.27).

Cumulative effects are the incremental effect of the proposed action when added to the effects of past, other present, or reasonably foreseeable future actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over time. For example, the intent of the alternatives is to develop a harvest management range that provides for the subsistence needs of the communities. However, the effects of the alternatives must also be evaluated as part of all relevant resources and activities within the action area.

4.1 Thresholds and Criteria for Determining Significance of Alternatives

Significance is determined by considering the context in which the action will occur and the intensity of the action. The context in which the action will occur includes the specific resources, ecosystem, and the human environment affected. The intensity of the action includes the type of impact (beneficial versus adverse), duration of impact (short versus long term), magnitude of impact (minor versus major), and degree of risk (high versus low level of probability of an impact occurring). Further tests of intensity include: (1) the potential for jeopardizing the sustainability of any target or non-target species; (2) substantial damage to ocean and coastal habitats and or essential fish habitat; (3) impacts on public health or safety; (4) impacts on endangered or threatened species, marine mammals, or critical habitat of these species; (5) cumulative adverse effects; (6) impacts on biodiversity and ecosystem function; (7) significant social or economic impacts; and (8) degree of controversy (NAO 216-6, Section 6.02).

The terms "effects" and "impacts" are used interchangeably in preparing these analyses. The CEQ regulations for implementing the procedural provisions of NEPA, also state "Effects and impacts as used in these regulations are synonymous." (40 CFR §1508.8). The terms "positive" and "beneficial", or "negative" and "adverse" are likewise used interchangeably in this analysis to indicate direction of intensity in significance determination.

Each of the following sections contains a summary of the direct, indirect or cumulative effects of the action using criteria established to determine significance, insignificance or unknown for each resource, species, or issue being evaluated. The criteria for significance and determinations of significance are summarized in a table in each section, or when the same criteria were used to evaluate subsequent species, the reader is referred back to the appropriate table.

The following ratings for significance are used; significant (beneficial or adverse), conditionally significant (beneficial or adverse), insignificant, and unknown. Definitions of the criteria used for these rankings are included in each section. Where sufficient information is available, the discussions and rating criteria used are quantitative in nature. In other instances, where less information on the direct and indirect effects of the alternative are available, the discussions and rating criteria used are qualitative in nature. In instances where criteria do determine an aspect of significance (significant negative, insignificant, or significant positive) because that aspect is not logically describable, no criteria are noted. These situations are termed "not applicable" or NA in the criteria tables. See below for further information:

S+ Significant beneficial effect in relation to the reference point (the reference point for effects of the harvest would be the recovery rate without a harvest, See Chapter 4.1).

S- Significant adverse effect in relation to the reference point and based on ample information.

CS+ Conditionally significant beneficial effect in relation to the reference point. This determination may be lacking in quantitative data and information, however, the judgement of the NMFS analysts who addressed the topic is that the alternative will cause an improvement in the reference point condition.

CS- Conditionally significant adverse effect in relation to the reference point; it may be based on insufficient data and information, however, professional judgement is that the alternative may cause a delay in the reference point condition (delay in recovery) or loss of tradition or culture.

I Insignificant effect in relation to the reference point; this determination is based upon information and data, along with the judgement of NMFS analysts, which suggests that the effects are small and within the "normal variability" surrounding the reference point.

U Unknown effect in relation to the reference point; this determination is characterized by the absence of information and data, or equivocal determination. In instances where the information available is not adequate to assess the significance of the impacts on the resource, species, or issue, no significance determination was made, rather the particular resource, species, or issue was rated as unknown.

In this analysis we use the term "conditionally significant" to describe a significant impact that is informed by incomplete or unavailable information. The conditional qualifier implies that significance is assumed, based on the credible scientific information and professional judgement that are available, but more complete information is needed for certainty. In other words, we may find that an impact has a significant adverse or a significant beneficial effect, but we do not have a high level of certainty about that finding. This approach provides a heightened sense of where information is lacking, and may guide research efforts in the future. An interesting point to make about this approach is that if an impact is rated as insignificant, there is a high level of confidence that the impact is truly insignificant, or it would have been moved to the "conditional significance" category.

4.1.1 Biological Criteria for Determining Effects of the Harvest

The criteria used to measure the direct effects of the harvest for significance was a comparison of the the total number of takes (level of harvest) to the Potential Biological Removal (PBR) level which is calculated for the northern fur seal stock. A PBR calculation is the most applicable measure of significance for the direct effects of this particular action.

Under the 1994 reauthorized MMPA, the PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: therefore $PBR = Nmin \times 0.5Rmax \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for depleted stocks under the MMPA (Wade and Angliss 1997). Thus, for this stock of northern fur seals, PBR = 16,162 animals (751,714 × 0.043 × 0.5).

4.1.2 Co-management as a Criteria - Shared Responsibilities under Section 119 of the MMPA

In April 1994, the MMPA was amended to include Section 119 "Marine Mammal Cooperative Agreements in Alaska." Section 119 formalizes the rights of Alaska Native Organizations to participate in conservation-related co-management of subsistence resources and their use. NMFS and the Tribal Government of St. Paul Island, and the Tribal Government of St. George Island, entered into cooperative agreements in 2000 to work in partnership to achieve the following: Promote the conservation and preservation of fur seals and sea lions; to use traditional knowledge, wisdom and values, and conventional science in research, observation, and monitoring efforts to establish the best possible management actions for the protection and conservation of fur seals and sea lions on the Pribilof Islands; to establish a process of shared local responsibilities regarding the management and research of fur seals and sea lions on behalf of the citizens of the United States; to identify and resolve through a consultative process any management conflicts that may arise in association with fur seals and sea lions on the Pribilof Islands; and to provide information to hunters and the affected community, as a means of increasing the understanding of the sustainable use, management, and conservation of fur seals and sea lions. A most significant tenet in this agreement is the concept of shared management between between members of the Tribal Governments and NMFS in the conservation and management of fur seals and sea lions for the year 2000 and thereafter.

As the primary customary/traditional users of the fur seals and sea lions in the Bering Sea Region, the Aleut Communities of St. Paul and St. George committed to the long term sustainable use of these animals for cultural continuity, food, clothing, arts, and crafts. A key to the success of this partnership is to incorporate the spirit and intent of co-management by building trust and by establishing close cooperation and communication between the Parties in the agreements.

Therefore, it is difficult to quantify this understanding for purposes of establishing criteria for NEPA. However, it can be generally considered that any departure from this agreement for purposes of establishing harvest ranges would be considered significant. The agreements provide for full partnership and full participation in decisions affecting the management of marine mammals used for subsistence purposes on the Pribilof Islands. An insignificant finding, then, would be one that is consistent with the intent and language of the agreements.

4.2 Direct Effects of the Alternatives on the Harvest on Fur Seals

Since the first Aleuts came to the islands in the late 1700s, fur seal meat has been a dietary staple. The Pribilof Aleuts use many parts of the fur seal for food. The number of seals estimated to be needed for subsistence purposes has varied dramatically since 1985, ranging from as many as greater than 15,000 per year (upper limit in the 1985 EIS) to the current estimate of several thousand when both islands are combined. Alaska Natives residing on the Pribilof Islands are allowed an annual subsistence harvest of northern fur seals, with a take range determined from annual household surveys. The estimate of subsistence needs for fur seals on the Pribilofs provided in the preamble to the 1985 Interim rule ranged from 3,358 to over 15,000. These estimates were derived from a variety of historical records and extrapolations based on subsistence use and the actual numbers harvested never approached the upper estimate of need. A total of 3, 713 seals were harvested in 1985. The harvest report was published in Marine Fisheries Review in 1986. The actual number needed and the manner in which the seals were taken was the subject of controversy between the cessation of the commercial harvest and the early 1990s, resulting in litigation between NMFS and conservation groups over this practice. Since 1995 the harvest has stabilized and the controversy is no longer.

Regulations governing the subsistence harvest are more restrictive regarding sex, size and age of harvested seals than those in effect during the years of the commercial harvest. Only subadult males between 2 and 4 years of age ,and greater than 124 centimeters in length, are allowed to be taken in the subsistence harvest. The actual number of seals taken for subsistence each year has been less than that estimated since 1997 and the harvest has become more efficient each year (see Table 1).

From 1986 to 1996, the annual subsistence harvest level averaged 1,412 and 193 for St. Paul and St. George Islands, respectively, for a total of 1,605. The subsistence harvest levels from 1997-01 were 1,380, 1,558, 1,193, 750, and 781, respectively. The average subsistence harvest level for1997-2001 is 1,132. Only juvenile males are taken in the subsistence harvest, which likely results in a much smaller impact on population growth than a harvest of equal proportions of males and females. A few females (3 in 1996, 3 in 1997, and 5 in 1998) were accidentally taken. Subsistence take in areas other than the Pribilof Islands is known to occur, though believed to be minimal. This total number of seals taken in the subsistence harvest is only a small fraction, and arguably an insignificant level, relative to the number of seals taken previously in the commercial harvest. The subsistence take since 1985 is not considered responsible for the depleted determination.

4.2.1 Setting the Harvest Range: The subsistence take ranges and actual harvest levels since the authorization of the subsistence harvest in 1985 are provided in Table 1. The number of northern fur seals harvested on St. Paul Island since 1986 has ranged from 597 (2001) to 1,710 (1987) (Table 1). The annual subsistence takes on St. George Island since 1986 have ranged from 92 (1987) to 319 (1993) seals (Table 1). The actual number of animals harvested has never reached the upper end of the estimated take range and has reached the lower range only once on St. Paul (1991) and twice on

St. George (1991, 1993) in the past 13 years (1989-2002). The average number of seals harvested during the past 10 years on St. Paul and St. George Islands has been 1,170 (range: 597 to 1,616) and 216 (range: 121 to 319), respectively.

Table 1. Subsistence Harvest Levels for Northern Fur Seals on the Pribilof Islands, 1985-2002.

Subsistence Take Ranges			Actual Harvest Levels	
Year	**St.Paul**	**St.George**	**St.Paul**	**St.George**
1985	--	--	3,384	329
1986	2,400-8,000	800-1,800	1,299	124
1987	1,600-2,400	533-1,800	1,710	92
1988	1,800-2,200	600-740	1,145	113
1989	1,600-1,800	533-600	1,340	181
1990	1,145-1,800	181-500	1,077	164
1991	1,145-1,800	181-500	1,645	281
1992	1,645-2,000	281-500	1,482	194
1993	1,645-2,000	281-500	1,518	319
1994	1,645-2,000	281-500	1,616	161
1995	1,645-2,000	281-500	1,525	260
1996	1,645-2,000	281-500	1,591	232
1997	1,645-2,000	300-500	1,153	227
1998	1,645-2,000	300-500	1,297	256
1999	1,645-2,000	300-500	1,000	193
2000	1,645-2,000	300-500	754	121
2001	1,645-2,000	300-500	597	184
2002	1,645-2,000	300-500	648	203

4.2.2 Effects of the Alternatives on Fur Seals

4.2.2.1 Evaluation of Alternative 1

The direct effects of this alternative on the fur seal stock would be no different than those for the past three years of the harvest. The status quo harvest has been measured for effect by comparing the harvest level against the PBR value in each assessment of the fur seal stock in the Alaska Marine Mammal Stock Assessment Reports (SARS) conducted annually by NMFS. Generally, PBR increases in significance and intensity as it approaches PBR and decreases as the level of harvest approaches zero. If the PBR is less than 10 percent of PBR the level is considered negligible under the MMPA, and not significantly different from zero. In all cases, the subsistence take ranges fall into the negligible range and, therefore, are not considered a significant action that my effect the population status of northern fur seals.

4.2.2.2 Evaluation of Alternative 2

Establishing take levels for the subsistence fur seal harvest on the Pribilofs less than those previously authorized would not have any significant adverse impact on the northern fur seal population. Since the harvest consists of subadult males, setting the harvest at a level less than the current levels would not likely have a beneficial effect. Therefore, lowering the harvest level would be insignificant.

An increase in harvest level might impact the fur seal stock if the need increased significantly. However, regulations prohibiting unnecessary waste of the animals taken would preclude such authorization unless a corresponding high level of subsistence need can be justified. The well documented history of the subsistence fur seal harvest on the Pribilofs clearly indicates that this scenario is highly unlikely to occur within the proposed action.

An increase in harvest level can be measured for effect by comparing the harvest level against the PBR value. Generally, PBR increases in significance and intensity as it approaches PBR and decreases as the level of harvest approaches zero. If the PBR is less than 10 percent of PBR the level is considered negligible under the MMPA, and not significantly different from zero. In all cases, the subsistence take ranges fall into the negligible range and, therefore, are not considered a significant action that my effect the population status of northern fur seals. Further, all the harvested animals, with very few exceptions, are non-breeding males and therefore do not contribute to the population growth. The subsistence harvest of these sub-adult males is not thought to have any impact on the population growth rates and therefore an increase or decrease in numbers harvested, as long as it was on males within this age-group, would likely result in less of an impact than indicated by simply calculating a PBR metric. The subsistence harvest of these sub-adult males is not thought to have any impact on the population growth rates and therefore an increase in numbers harvested, as long as it was on males within this age-group, would likely have a little, possibly, insignificant impact. Any increase demonstrated by need as required under the regulations would still result in a harvest that was significantly less than than PBR for this stock. Therefore, it is likely that the effects of a harvest under this alternative would also be insignificant.

4.2.3 Effects of the Alternatives - Co-Management and Shared Responsibilities

4.2.3.1 Evaluation of Alternative 1

Establishing take ranges at the same levels as those for the period 1997-1999 maintains a status quo level of take that has evolved and stabilized through years of cooperatively managing the subsistence harvest of northern fur seals on the Pribilof Islands. The subsistence component of these communities has remained an important, consistent and supporting factor in the personal, economic and traditional character of the Pribilof Islands which NMFS and local tribal governments believe will be preserved by this alternative. For that reason, this is the preferred alternative by NMFS. The indirect effects of establishing take ranges and allowing the harvest to go forward as defined have been agreed upon by Parties in the cooperative agreements and are, therefore, considered insignificant.

4.2.3.2 Evaluation of Alternative 2

Setting the subsistence harvest take ranges at levels other than those first established and maintained during the 3 year period 1997-1999 would be considered conditionally significant on the human environment.

Setting the take ranges at levels lower than those established and maintained during the 3 year period 1997-1999 could possibly have an adverse impact on the human environment if the levels were such that the subsistence needs of the local communities were not adequately met. The economic and logistical difficulties associated with small, rural and remote Alaskan communities such as those of St. Paul and St. George Islands, create a situation wherein subsistence uses of marine mammals is an important source of food and a major component of the traditional character of the communities. Therefore, establishing take ranges that do not meet the subsistence needs of the local communities would impose a variety of significant hardships for individual residents and the community at large that could not be justified.

Further, a unilateral decision by NMFS to establish such take ranges would be counter to current regulations implementing the MMPA, as well as the spirit of co-management established in section 119 of the MMPA. This could result in significant damage to the relationship between NMFS and the local ANOs, than benefit to the fur seal stock.

4.2.4 Impacts of the Alternatives on Endangered or Threatened Species

The ESA establishes several levels of classification and criteria regarding the listing of wildlife species whose populations have reached levels warranting concern. Two of those levels are Threatened and Endangered. The northern fur seal species is not listed, or under consideration for listing, under the ESA and therefore, is nota listed species impacted by either of the alternatives considered.

Direct interactions of the subsistence harvest on listed species is most likely for Steller sea lions that occur on the islands of St. Paul and St. George. An interaction between the fur seal subsistence harvest and Steller sea lions could only occur through disturbance of a sea lion that might be hauled out on a rookery where juvenile male fur seals are being rounded up for harvest. This has never happened due in large part to the territorial behavior of fur seals on the rookeries. More simly stated, Steller sea lions do not occupy the active areas of the rookeries and therefore would not be disturbed by the harvest activity. Although Steller sea lions are also harvested for subsistence on the Pribilof Islands, they are not taken, either directly or indirectly, as a result of this action. Therefore there is no effect on Steller sea lions under either alternative or in a worse case scenario, the effect would be insignificant.

Seven species of large whales that occur in Alaskan waters are also listed under the ESA including: the North Pacific right whale, blue whale, fin whale, sei whale, humpback whale, sperm whale, and bowhead whale. Three species of marine birds are also listed under the ESA and occur in the action area. Previous NEPA analyses have measured effects of the alternatives on listed species in terms of four potential effects: 1) direct (or incidental) take/entanglement in marine debris, 2) harvest of prey species, 3) temporal/spatial concentration of the fishery, and 4) disturbance. In all cases, the direct effects of either of the alternatives considered in this proposed action will have no effect on listed great whales or seabirds.

4.2.4.1 Re-initiation of Consultation under Section 7 of the ESA

If significant or adverse effects on listed species were found as a result of the proposed action, there would be a need to reinitiate formal consultation, pursuant to Section 7 of the ESA. Neither of the alternatives were found to negatively effect ESA listed pinniped, cetaceans or seabirds by an increase in take. Similarly, these actions will not affect critical habitat for Steller sea lions or seabirds. Critical habitat has not been designated for ESA listed cetaceans. Consequently, re-initiation of ESA Section 7 consultation is not necessary as a result of this action.

4.2.5 Effects of the Alternatives on Other non-listed Marine Mammals

4.2.5.1 Pinnipeds

The "other pinnipeds" group includes the harbor seal and the ice seals (spotted, bearded, ringed, and ribbon seals), and Pacific walrus. The action described in the alternatives described will have little or no effect on those species.

In particular, the ice seal distributions tend toward seasonally or permanently ice-covered waters of the Beaufort, Chukchi, Bering, and Okhotsk Seas, which are generally north of most areas commercially fished for groundfish. The annual distribution of the seals depends on the extent of the sea ice, which can vary widely from year to year (Burns *et al.*, 1981a, b). The sea ice in the Bering Sea typically extends to the continental shelf break, but in heavy ice years, the ice edge can extend as far south as the eastern Aleutian Islands, while in light ice years, the ice edge can be as far north as St. Lawrence Island (Burns *et al.*, 1981b). Occasionally, individuals of each species can be found south of the ice edge in the Bering Sea, but infrequent contacts with the Pribilof Islands would not precipitate population level effects. In all cases, the direct and indirect effects of all alternatives are expected to have insignificant effects on other pinnipeds because there is little to no spatial and temporal, or dietary overlap, of ice seals, and walruses with the Pribilof Islands.

4.2.5.2 Effects of the Alternatives on Other Cetaceans Besides ESA Listed Species

Ten species of whales and dolphins occur in Alaskan waters and are protected under the MMPA (but not listed under the ESA) including: the gray whale, minke whale, beluga whale, killer whale, Pacific white-sided dolphin, harbor porpoise, Dall's porpoise and beaked whales (Baird's, Cuvier's and Stejneger's). In all cases, there are no direct or indirect effects of the alternatives on cetaceans.

4.2.6 Effects of Alternatives on Essential Fish Habitat (EFH)

The two issues of prime concern with respect to EFH effects are the potential for damage or removal of fragile biota that are used by fish as habitat, the potential reduction of habitat complexity, which depends on the structural components of the living and nonliving substrate; and potential reduction in benthic diversity from long-lasting changes to the species mix.

A qualitative review of the alternatives as to the significance of the effects on EFH resulted in an insignificant finding. The following criteria, grouped into five categories were used:

1. Damage to or removal of Habitat Areas of Particular Concern (HAPC) biota by trawl gear
2. Damage to or removal of HAPC biota by fixed gear
3. Modification of nonliving substrate, and/or damage to small epifauna and infauna by trawl gear
4. Modification of nonliving substrate, and/or damage to small epifauna and infauna by trawl gear
5. Reduction in benthic biodiversity

HAPC biota are taxa which form living substrate, and are identified by NMFS as meeting the criteria for special consideration in resource management. Several groups of organisms have been identified as HAPC in Alaska: coral, sponges, anemones, sea whips and sea pens. Bycatch of HAPC species in both trawl and longline gear is of concern. Concentrations of HAPC species often occur in nearshore shallow areas but also are found in offshore deep water areas with substrata of high microhabitat diversity.

EFH may be effected through modifications to the nonliving substrate in which they live have been combined, and/or damage to small epifauna and infauna by trawling. Intensive fishing in an area can result in a change in species diversity by attracting opportunistic fish species which feed on animals that have been disturbed in the wake of the tow, or by reducing the suitability of habitat used by some species.

The alternatives presented here do not in any manner have an effect on EFH or other habitat in the EBS or BSAI. The effects of harvest alternatives on EFH are considered insignificant.

4.2.7 Effects of Alternatives on Enforcement

Both, enforcement of the alternatives and safety measures taken to implement the preferred alternatives are shared responsibilities between NMFS and the two Tribal Governments as specified in the co-management agreements. The agreements have the following specifications with regards to enforcement on the rookeries and during the harvest:

> [from Agreement] To effectively implement this Agreement, the Parties agree that:
>
> The TGSNP [tribal government] recognizes the Secretary of Commerce's authority to

enforce the provisions of the MMPA, ESA and Fur Seal Act applicable to the subsistence harvest of fur seals and sea lions; and

NMFS recognizes the existing Tribal authority to govern and regulate their members and conduct regarding the traditional uses of fur seals and sea lions, and acknowledges tribal authority to conduct the following in cooperation with NMFS:

1. Conduct rookery disturbance monitoring and local enforcement upon closing of the rookeries and to monitor sea lion hunting activities;

2. Conduct access permitting for the fur seal viewing blinds and fur seal harvest;

3. Develop and implement Tribal ordinances governing the hunting of sea lions and harvesting of fur seal and provide NMFS with up to date Tribal ordinances;

4. Develop and implement effective local processes for informing the public regarding applicable Federal and Tribal laws and regulations;

5. Develop and implement cooperative enforcement plans between Federal, local and Tribal authorities; and

6. Review, recommend, and advise on revisions to federal regulations governing fur seals and sea lions.

As a result of the enforcement provisions of the agreement, there is no increased demands on NOAA Enforcement under Alternative 1 vs. Alternative 2. Therefore the direct effects of either alternative on levels of required enforcement are similar. The effects on NOAA enforcment are also insignificant.

4.2.8 Effects of Alternatives on Safety and Health

Safety factors are considered an inherent part of the action and it is incumbent upon the Tribal Governments to invoke safety measures while conducting the harvest. Implementing the preferred alternative does not require a significant increase in special precautions that need to be taken prior to the harvest. To provide for the maximum in safety precaution several components of the co-management agreements focus on safety and Tribal Elders emphasize safety during the conduct of the harvests. Given the level of experience of hunters in the harvest, the hunting tradition passed from generation to generation, and the long tradition of conducting this harvest, none of the risks associated with the alternatives are considered significant.

4.3 Indirect Effects of the Alternatives

4.3.1 Effects on Fur Seals

There are no indirect effects of either Alternative 1 or Alternative 2 on the fur seal stock. The effect of a subsistence harvest is largely direct. This is particularly so in this example because all the harvested animals, with very few exceptions, are non-breeding males and therefore do not contribute to the population growth. The subsistence harvest of these sub-adult males is not thought to have any long-term impacts on the population growth rates and therefore an increase or decrease in numbers harvested, as long as it was on males within this age-group, would likely result in less of an impact than indicated by simply calculating a PBR metric. The subsistence harvest of these sub-adult males is not thought to have any impact on the population growth rates and therefore an increase in numbers harvested, as long as it was on males within this age-group, would have an insignificant impact. Any increase demonstrated by need as required under the regulations would still result in a harvest that was significantly less than than PBR for this stock.

4.3.2 Indirect Effects of the Alternatives on Co-Management

The indirect effects of the alternatives on the cooperative management of fur seals under the agreements are the same as for the direct effects. The preferred alternative (Alternative 1) will result in no significant effects. Harvesting seals at a level not agreed upon by both parties to the agreements (Alternative 2) would be significant.

4.3.3 Impacts of the Alternatives on Endangered or Threatened Species

The indirect effects of the alternatives on ESA listed species are insignificant to none. There are no ESA listed species taken as part of these actions either directly or indirectly through harassment or harvest.

4.3.4 Effects of the Alternatives on Other non-listed Marine Mammals

The "other pinnipeds" group includes the harbor seal and the ice seals (spotted, bearded, ringed, and ribbon seals), and Pacific walrus. The action described in the alternatives described will have no effect on other marine mammal species in the action area. There would be no other marine mammal species taken as a result of implementing either of these alternatives either directly or indirectly through harassment or harvest.

4.3.5 Effects of Alternatives on Essential Fish Habitat (EFH)

The alternatives presented here do not in any manner have an indirect effect on EFH or other habitat. The indirect effects of harvest alternatives on EFH are considered insignificant.

4.3.6 Effects of Alternatives on Enforcement

The indirect effects of the alternatives on enforcement are the same as the direct effects. Both, enforcement of the alternatives and safety measures taken to implement the preferred alternatives are shared responsibilities between NMFS and the two Tribal Governments as specified in the co-management agreements (see section 4.2.6). As a result of the enforcement provisions of the agreement, there is no increased demands on NOAA Enforcement under Alternative 1 vs. Alternative 2. Therefore the effects of either alternative on levels of required enforcement are similar. The effects on NOAA enforcment are also insignificant.

4.3.7 Effects of the Alternatives on Safety and Health

Safety factors when considering subsistence harvests are considered an inherent part of the action and it is incumbent upon the Tribal Governments to invoke safety measures while conducting the harvest. Implementing the preferred alternative does not require a significant increase in special precautions that need to be taken prior to the harvest. To provide for the maximum in safety precaution several components of the co-management agreements focus on safety and Tribal Elders emphasize safety during the conduct of the harvests. Given the level of experience of hunters in the harvest, the hunting tradition passed from generation to generation, and the long tradition of conducting this harvest, none of the risks associated with the alternatives are considered significant.

4.4 Summary of Direct and Indirect Effects of Harvests on Fur Seals and the Environment

Neither of the proposed alternatives will significantly affect the stock of northern fur seals. Under the preferred alternative the maximum number of seals taken annually would be less than 2,500 if all the allowable take were harvested. The PBR for this stock of marine mammals is16,162 animals. A harvest of the proposed magnitude is significantly less than PBR. Since 1997 the number of seals harvested per year has been less than 1,600 animals and the trend in recent years has been for fewer seals to be taken each year (see Table 1). This is less than 10 percent of the estimated PBR which is considered negligible under the MMPA (i.e, not significantly different from zero).

The alternatives do not effect any other wildlife. The proposed action is limited to a harvest of fur seals on rookeries. No endangered or threatened species or their critical habitat will be affected by this action.

The preferred alternative would meet the documented subsistence needs of the Aleuts on St. Paul and St. George Islands and is consistent with MMPA Federal law.

The proposed actions promote cultural diversity and recognizes the importance of maintaining traditions for Alaska native groups. The proposed action does not set any precedent that could increase the subsistence hunting pressure on northern fur seals.

The preferred alternative would not have a significant impact on the general public.

Table 4.1 Summary of direct and indirect effects of Alternatives on fur seals and the subsistence users, and effects on enforcement.

Activity	Direct and Indirect Effects of Alternatives on Environment	
	Alternative 1	**Alternative 2**
Potential Biological Removal Rate (PBR)	I	I/U
Subsistence Need	I	U
Shared Responsibility under Co-management	I	S-
ESA listed Species	I	I
Essential Fish Habitat	I	I
Safety and Health	I	I
Other Marine Mammals	I	I
Commercial Fishing	I	I
S = Significant, CS = Conditionally Significant, I = Insignificant, U = Unknown, + = positive, - = negative		

The proposed actions will not cause substantial damage to the ocean or habitats, or EFH. There is no incidental take of other species during the harvest. The level of harvest is not inhibiting the increase of this population.

For these reasons NMFS has determined that the selection of the preferred "status-quo" alternative (Alternative 1) will, by itself, have neither a direct or indirect significant impact on fur seals or the overall quality of the human environment or cause any adverse impacts on any wildlife species listed under the ESA or MMPA.

4.5 Cumulative Effects

A cumulative effects analysis is a requirement of NEPA. An environmental assessment or environmental impact statement must consider cumulative effects when determining whether an action significantly affects environmental quality. The Council on Environmental Quality (CEQ) guidelines for evaluating cumulative effects state that "…the most devastating environmental effects may result not from the direct effects of a particular action but from the combination of individually minor effects of multiple actions over time." (CEQ 1997).

The CEQ regulations for implementing NEPA define cumulative effects as:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

A cumulative effects analysis takes into account the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). Cumulative effects may result in significant effects even when the Federal action under review is insignificant when considered by itself. The CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action on the universe but to focus on those effects that are truly meaningful. This section analyzes the potential direct and indirect effects of other factors that may in the aggregate, and in combination with the subsistence harvest of fur seals, result in greater effects on northern fur seals or their biological environment than those resulting solely from the subsistence harvest.

The methodology for conducting the cumulative effects analysis in this EIS is the same as that followed in the Steller Sea Lion Protection Measures Draft Supplemental EIS (NMFS, 2001).

4.5.1 Methodology

The intent of the cumulative effects analysis is to capture the total effects of many actions over time that would be missed by evaluating each action individually. A cumulative effects assessment describes the additive and synergistic result of the actions proposed in this SEIS as they interact with factors external those proposed actions. To avoid the piecemeal assessment of environmental impacts, cumulative effects were included in the 1978 CEQ regulations, which led to the development of the CEQs cumulative effects handbook (CEQ 1997) and federal agency guidelines based on that handbook (e.g., EPA 1999). Although predictions of direct effects of individual proposed actions tend to be more certain, cumulative effects may have more important consequences over the long term. The possibility of these "hidden" consequences presents a risk to decision makers, because the ultimate ramifications of an individual decision might not be obvious. The goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of alternative management actions.

The methodology for cumulative effects analysis in this EA is taken from the Steller Sea Lion Protection Measures Final SEIS (2001). It consists of the following steps:

- *Identify characteristics and trends within the affected environment that are relevant to assessing cumulative effects of the action alternatives.*

- *Describe the potential direct and indirect effects* - The alternatives reviewed in this EIS would be similar in their effects on the environment and are treated together. For example, each of the alternatives would have a similar additive effect if considered with the potential effects of habitat loss on fur seals. The effect of either of the alternatives is largely a null effect or "sum-zero". Therefore, the potential cumulative effect on fur seals is largely the result of the effect of the external activity when considered with the harvest, not the direct or indirect effect of the harvest alternatives themselves.

- *Identify past, present and reasonably foreseeable external factors such as other fisheries, other types of human activities, and natural phenomena that could have additive or synergistic effects* - Past actions must be evaluated to determine whether there are lingering effects that may still result in synergistic or incremental impacts when combined with the proposed action alternatives. The CEQ guidelines require that cumulative effects analysis assess reasonably foreseeable future actions. In these analyses the most significant past action was the commercial harvest; the most significant current actions evaluated were the commercial fisheries (human related) and the changing environment (natural).

- *Evaluate the significance of the potential cumulative effects using criteria established for direct and indirect effects and the relative contribution of the action alternatives to cumulative effects*- Of particular concern are situations where insignificant direct and indirect effects lead to significant cumulative effects or where significant external effects accentuate significant direct and indirect effects. The CEQ guidelines require that cumulative effects analysis assess reasonably foreseeable future actions. In these analyses the most significant past action was the commercial harvest; the most significant current actions evaluated were the commercial fisheries (human related) and the changing environment (natural); and

- *Discuss the reasoning that led to the evaluation of significance, or lack of significance, citing evidence from quantitative information where available.*

The advantages of this approach are that it (1) closely follows CEQ guidance, (2) employs an orderly and explicit procedure, and (3) provides the reader with the information necessary to make an informed and independent judgment concerning the validity of the conclusions. Further this approach was used in the analysis of effects of the groundfish fishery on Steller sea lions in the BSAI at NMFS (2001). In those analyses the cumulative effects of those actions (the fishery) and the environment on the fur seal stock was reviewed in detail. Much of those analyses and text is applicable to the cumulative effects of activities in the BSAI and EBS on northern fur seals. Therefore, the following sections rely heavily on previous analyses in Section 4, NMFS (2001).

4.5.1.1 External Factors and Effects

For the purposes of this EA, the definition of other or "external" actions includes both human controlled events such as industrial development, and natural events such as disease, natural mortality or predation, and short and long term climate change.

- *Effects from fisheries* - Direct catch, bycatch, and direct and indirect mortality from ,

2. *Effects from commercial hunting and harvesting* - approved commercial marine mammals and subsistence harvests.

- *Effects from Environmental Change* - reduced carrying capacity.

Other external actions may also be significant but need not be examined further to determine significance at this time. These include oil and gas activities, creation of infrastructure (ports and harbors) and commercial shipping effects. They will be reviewed and analyzed for effect in detail in the subsequent EIS.

4.5.1.2 Thresholds and Criteria for Determining Significance

The criteria for significance and determinations of cumulative effects significance are the same as those used to analyze the direct and indirect effects of the alternatives on the environment.

The following ratings for significance are used; significant (beneficial or adverse), conditionally significant (beneficial or adverse), insignificant, and unknown. Definitions of the criteria used for these rankings are included in each section. Where sufficient information is available, the discussions and rating criteria used are quantitative in nature. In other instances, where less information on the direct and indirect effects of the alternative are available, the discussions and rating criteria used are qualitative in nature. In instances where criteria do determine an aspect of significance (significant negative, insignificant, or significant positive) because that aspect is not logically describable, no criteria are noted. These situations are termed "not applicable" or NA in the criteria tables. See below for further information:

S+ Significant beneficial effect in relation to the reference point (reference point would be takes relative to PBR for direct effects).

S- Significant adverse effect in relation to the reference point and based on ample information.

CS+ Conditionally significant beneficial effect in relation to the reference point. This determination may be lacking in quantitative data and information, however, the judgement of the NMFS analysts who addressed the topic is that the alternative will cause an improvement in the reference point condition.

CS- Conditionally significant adverse effect in relation to the reference point; it may be based on insufficient data and information, however, professional judgement is that the alternative may cause a delay in the reference point condition (delay in recovery) or loss of tradition or culture.

I Insignificant effect in relation to the reference point; this determination is based upon information and data, along with the judgement of NMFS analysts, which suggests that the effects are small and within the “normal variability” surrounding the reference point.

U Unknown effect in relation to the reference point; this determination is characterized by the absence of information and data, or equivocal determination. In instances where the information available is not adequate to assess the significance of the impacts on the resource, species, or issue, no significance determination was made, rather the particular resource, species, or issue was rated as unknown.

4.5.2 Direct Cumulative Effects

4.5.2.1 Effects of the Commercial Harvest on Fur Seals

The impacts of the commercial fur seal harvest on the Pribilof Islands have been well documented and are summarized in the conservation plan for the northern fur seal (NMFS 1993) and Chapter 1.2.1 of this EA. The commercial harvest reduced the stock by greater than 50 percent leading to a depleted determination under the MMPA in 1988. This designation was the result of the large-scale commercial harvest during this 198 year period and the lack of recovery since its cessation. In 1985 the commercial harvest was terminated and the subsistence harvest by Aleut residents of the Islands was authorized. Historically, the effect of the commercial harvest is considered significant.

4.5.2.2 Other Direct Mortality

Intentional killing of northern fur seals by commercial fishers, sport fishers, and others may occur. Such shooting has been illegal since the species was listed as “depleted” in 1988. The magnitude of this shooting is unknown.

4.5.2.3 Effects of Other On-land Mortality

Based on limited data, there is no evidence that on-land natural mortality has increased for any year-class, and the levels of mortality reported are too low to have made a significant contribution to the decline in the population since the mid 1970s. In part, this reflects the fact that pup mortality on land is density dependent (York, 1985; Fowler, 1987b). At high population levels pup mortality is high, and at low population levels pup mortality is low (Fowler, 1985a). In the 1940s and 1950s when the population was high, pup mortality on land was 10 to 22 percent. Between 1976 and 1986, annual pup mortality on land decreased from 6-10 percent to 3.7 percent, concurrent with the decline in the total population (based on an analysis of raw data in York and Kozloff, 1987). This density-dependent relationship between pup survival and pup abundance has remained relatively unchanged since the 1940s (Fowler, 1984).

The most common cause of mortality among pups on the Pribilof Islands during the first 2 months of life is emaciation (Keyes et aI., 1979). However, the frequency of this and other causes of mortality, such as hookworm disease, tend to be cyclic (Keyes et aI., 1979). Of 109 dead pups examined in 1964, 37.6 percent had died from starvation, 17.4 percent from trauma, 12.0 percent from hookworm disease, 4.6 percent *from* gastrointestinal infection, and 11.0 percent *from* miscellaneous infections (Keyes, 1965). Between 1974 and 1977, the primary causes of pup deaths in 725 pups were hookworm (45 percent), starvation (34 percent), microbial infections (14 percent), trauma (3 percent), and miscellaneous (4 percent) (Gentry, 1981). The causes of death *for* approximately 1,025 fur seal pups *from* 1986 to 1991 were emaciation (40 percent), trauma-blunt (18 percent)/trauma-sharp (4 percent), stillborn (8 percent), pneumonia (5 percent), fetal anomalies (1 percent), miscellaneous (18 percent), and undetermined/no gross lesions (6 percent) (Spraker et al.1991).

Pup weight is also an important component of mortality because larger body size may be advantageous to individuals facing their first winter. Baker and Fowler (1992) reviewed studies where juvenile weight was shown to be positively correlated with survival for several mammalian species. With regards to fur seals, these authors found that seal pups who weighed more than their cohort's mean weight had a significantly greater chance of surviving to at least age 2. They concluded that pup weight significantly influences post-weaning survival at sea. Calambokidis and Gentry (1985) also found that pups weighing less than the average pup at birth, or those born to young mothers « 7 years old), had a greater probability of dying within the first 4 weeks of life when compared to pups of average birth weight from older females.

The information on cumulative effects of natural mortality in early life stages on the fur seal stock is considered equivocal. While it is believed to be insignificant, for purposes of the EA it is considered unknown at this time.

4.5.2.4 Direct Effects of Commercial Fisheries

(i) Incidental Mortality due to Fishing

NMFS estimates that the total number of northern fur seals killed incidental to both the foreign and the joint U. S.-foreign commercial groundfish trawl fisheries in the North Pacific from 1978 to 1988 was 246 (95% CI: 68 - 567), resulting in an estimated mean annual rate of 22 northern fur seals (Perez and Loughlin 1991). The foreign high seas driftnet fisheries also incidentally killed large numbers of northern fur seals, with an estimated 5,200 (95% CI: 4,500 - 6,000) animals taken during 1991 (Larntz and Garrott 1993). These estimates were not included in the mortality rate calculation because the fisheries are no longer operative, although some low level of illegal fishing may still be occurring. Commercial net fisheries in international waters of the North Pacific Ocean have decreased significantly in recent years. The assumed level of incidental catch of northern fur seals in those fisheries, though unknown, is thought to be minimal (T. Loughlin, pers. comm., National Marine Fisheries Service).

Six different commercial fisheries in Alaska that could have had direct interactions with northern fur seals were monitored for incidental take by fishery observers during 1990-2001: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries, and Gulf of Alaska groundfish trawl, longline, and pot fisheries. The only observed fishery in which incidental mortality occurred was the Bering Sea and Aleutian Islands groundfish trawl (Table 5), with a mean annual (total) mortality of 1.2 (CV = 3). In 1990 and 1991, observers monitored the Prince William Sound salmon drift gillnet fishery and recorded no mortalities of northern fur seals. In 1990, observers boarded 300 (57.3%) of the 524 vessels that fished in the Prince William Sound salmon drift gillnet fishery, monitoring a total of 3,166 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). In 1991, observers boarded 531 (86.9%) of the 611 registered vessels and monitored a total of 5,875 sets, or roughly 5% of the estimated sets made by the fleet (Wynne et al. 1992). During 1990, observers also boarded 59 (38.3%) of the 154 vessels participating in the Alaska Peninsula/Aleutian Islands salmon drift gillnet fishery, monitoring a total of 373 sets, or roughly 4% of the estimated number of sets made by the fleet (Wynne et al. 1991). Although no interaction with northern fur seals was recorded by observers in 1990 and 1991 in these fisheries, due in part to the low level of observer coverage, mortalities did occur as recorded in fisher self-reports (see Table 4.1).

An additional source of information on the number of northern fur seals killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1999, fisher self-reports from three unobserved fisheries (see Table 4.1) resulted in an annual mean of 14.5 mortalities from interactions with commercial fishing gear. While logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), the bias in these estimates are hard to quantify because at least in one area (Prince William Sound), it is unlikely that fur seals occur and reports of fur seal-fishery interactions are likely the result of species misidentification. The great majority of the incidental take in fisher self-reports occurred in the Bristol Bay salmon drift net fishery. In 1990, self-reports from the Bristol Bay set and drift gillnet fisheries were combined. As a result, some of the northern fur seal mortalities reported in 1990 may have occurred in the set net fishery. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-95 phase-in period is fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums.

No observers have been assigned to several of the gillnet fisheries that are known to interact with this stock, making the estimated mortality unreliable. However, the large stock size makes it unlikely that unreported mortalities from those fisheries would be a significant source of mortality for the stock. The estimated minimum annual mortality rate incidental to commercial fisheries is 17 fur seals per year based on observer data (1.2), and self-reported fisheries information (16) where observer data were not available.

In summary, observer records from 1990 to 1999 indicate that direct interactions with groundfish vessels occurred only in the BSAI trawl fishery, despite observer placement in pot, longline and trawl fisheries in both the BSAI and GOA. In the BSAI trawl fishery, the average annual take rate (1994 to 1998) was 1.4. This level of take contributes little to the northern fur seal potential biological take (PBR) of 18,244 (Ferrero *et al.,* 2000) and is inconsequential to population trends. It is therefore considered insignificant for purposes of this analyses.

(ii) Effects of Entanglement in Fishing Gear

Northern fur seal entanglement in marine debris is more common than any other species of marine mammal in Alaskan waters (Laist, 1987, 1997; Fowler, 1987). Mortality resulting from entanglement in marine debris has been implicated as a contributing factor in the decline observed in the northern fur seal population on the Pribilof Islands during the 1970s and early 1980s (Fowler 1987, Swartzman et al. 1990).

Surveys conducted from 1995 to 1997 on St. Paul Island indicate a rate of entanglement among subadult males comparable to the 0.2% rate observed from 1988 to 1992 (Fowler and Ragen 1990, Fowler et al. 1994), which is lower than the rate of entanglement (0.4%) observed during 1976-85 (Fowler et al. 1994). During 1995-97, NMFS researchers in conjunction with members of the Aleut communities of St. Paul and St. George Islands captured and removed entangling debris (including trawl net, packing bands, twine, and miscellaneous items) from 88, 146 and 87 northern fur seals, respectively.

Laist (1997) suggested that modest signs of northern fur seal population recovery in recent years may be an indication that entanglement in net debris is among the factors impeding population recovery. The contribution of intentional discard of net debris from Alaskan groundfish fisheries vessels is thought to have declined over the past decade. However, consistent numbers of seals entangled in packing bands on St. Paul Island may reflect disposal of these materials in proximity to the islands. Recent data from satellite-tracked drifters deployed in the Bering Sea suggests a "trapped" circulation pattern around the Pribilof Islands (Stabeno *et al.,* 1999) which may retain marine debris in the nearshore environment

Therefore, the effect of entanglement in discarded debris has been a potentially signficant factor in the past. At this time, it is still occurring, but the effect of this on fur seal stock status is considered unknown at this time.

4.5.2.5 Effects of Diseases and Parasites

The effects of diseases and parasites on fur seals between the late 1970s and the late 1980s were unknown. Necropsies of juvenile seals taken in the St. Paul Island subsistence harvest during the 1980s suggest that the population is relatively disease free compared to the period from the 1950s to early 1970s (NMML unpublished data). For example, mortality from ascarid (nematode worm) infection may have been important during the 1950s and 1960s (Neiland, 1961; Keyes, 1965), and while Leptospirosis was not identified until the 1970s (Smith et al. 1977). Thus, fur seals do succumb to diseases, as do all mammals. However, the relative importance of this form of natural mortality in the decline of the Pribilof Islands stock is unknown. Although natural conditions in the environment such as disease (and predation) have not been a significant threat to the fur seals in the past, disease should be considered a constant threat given the densities of fur seals (and their potential vulnerability to a disease) during the breeding season.

Given the information available the cumulative effect of disease on the fur seal status, mortality is considered unknown but not thought to be significant. Any significant declines due to disease factors should have been detected given the annual screening that occurs as part of the research program on St. Paul Island.

4.5.2.6 Effects of Predation

Captain Charles Bryant, first special agent of the Treasury Department, arrived on the Pribilofs in 1869 and stated that he took, respectively, 18 and 24 seal pups from the stomachs of two killer whales (original account chronicled by Lucas (1899) and reported in Scheffer et al. 1984). However, it has been since suggested that the record may have been incorrectly reported as being from the Pribilof area (Scheffer et al., 1984). The only authenticated stomach examination of a killer whale on the Pribilofs occurred in 1868 when a killer whale was seen "swimming with such force that he ran aground and was unable to get off. When the tides went out the whale was cut open and three seals were found in its stomach" (original record reported in Scheffer et al. 1984).

Preble and McAtee (1923) (as reported in Scheffer et al. 1984) gave numerous records of killer whales seen from 1875 to 1917. One killer whale seen off Reef rookery on December 2, 1902, "was playing havoc with a band of seals." At Northeast Point on November 6, 1904, "fragments of both cows and pups, the work of killer whales, were found strewn along the beach."

Killer whales have also been observed to attack fur seals near Robben Island (Bychkov 1967), but no information is available for the Pribilof Islands in recent years. The account by Scheffer et al. (1984) concluded by stating that "evidence of predation by killer whales upon seals has not, we believe, been reported since 1917. We [Scheffer et al. 1984] conclude that killer whales have not changed their habits, but that Pribilof residents now spend less time watching the beaches than they used to." It is not known to what extent killer whales prey upon fur seals in waters adjacent to the Pribilof Islands.

Other sources of mortality to pups is predation by foxes and northern sea lions. On three occasions, foxes have been seen attacking living pups (reported in Roppel, 1984). Northern sea lions have also been reported to kill weaned fur seal pups close to shore on St. George Island (Gentry and Johnson, 1981) but, generally, at rates considered too low (3.4-6.8 percent of neonates) to be considered significant to the decline of the Pribilof Island stock of fur seals. Mortality of fur seal pups by sea lions was also observed in 1992. However, in general, the effects of predation on the decline and recovery of fur seals are not considered to have had, nor are they considered to have presently, a major impact on the stock (Fowler, 1985a).

Given information available and recent changes in pinniped populations in the Bering Sea, and the effects of those changes on killer whale predation, the effects of predation on fur seals is unknown at this time.

4.5.3 Indirect Cumulative Effects

4.5.3.1 Indirect Cumulative Effects of Fishing on Fur Seals

Competition between fisheries, marine mammals, and seabirds has a long history and has been described from different perspectives. On one hand, fishermen have observed the numbers of target species that have been consumed by marine mammals and seabirds and treated the mammals and birds as economic competitors for their catch (Furness 1984). On the other hand, biologists and conservationists have observed the large amount of biomass that is removed from marine ecosystems by fisheries and have been concerned that the fisheries compete with marine mammal and seabird populations. However, it has been demonstrated at NMFS (2001) that an overlap between fur seal diets and foraging areas, and commercial catch of groundfish in the BSAI exists. This overlap between fishermen and fur seals suggests that these two consumers actively demand a common resource and may, as a result, be competitors for that resource.

(i) Potential Effects of Commercial Fishing on Disturbance to Northern Fur Seals by Commercial Fisheries

Disturbance from either vessel traffic or fishing activities may also be a disadvantage to marine mammals, particularly foraging animals. Vessel traffic alone may temporarily cause fish to compress into tighter, deeper schools (Freon et al. 1992) or split schools into smaller concentrations (Laevastu and Favorite 1988). However, disturbance effects on northern fur seal prey are difficult to identify. The potential for disturbance effects caused by vessel traffic, fishing gear, or noise appears limited for northern fur seals. Kajimura (in Johnson *et al.,* 1989) reported no response by fur seals when approached by ship, and NMFS observers on board Japanese driftnet vessels regularly reported fur seals in close proximity to both the gear and fishing vessels (International North Pacific Fisheries Commission [INPFC] reports from the 1980s). Interactions with other types of fishing gear, such as trawl nets, also appear limited based on the rare incidence of takes in groundfish fisheries. Thus, the measures under Alternative 1 are consistent with efforts to avoid these kinds disturbance effects on northern fur seals.

(ii) Potential Ecological Interactions Between Northern Fur Seals and Commercial Fisheries

Ecological interactions between marine mammals and commercial fisheries are, in most cases, difficult to identify. Examples of observable interactions are generally restricted to direct mortality in fishing gear. Even then, the ecological significance of the interaction is related to the number of animals killed and subsequent population level responses. No marine mammal incidental mortality estimates for Alaskan groundfish fisheries exceed the PBRs (Hill and DeMaster 1999); therefore, those interactions are not expected to have large ecosystem consequences.

More difficult to identify and potentially more serious are interactions resulting indirectly from competition for resources that represent both marine mammal prey and commercial fisheries targets. Such interactions may limit foraging success through localized depletion, disaggregation of prey, or disturbance of the predator itself. Compounding the problem of identifying competitive interactions is the fact that biological effects of fisheries may be indistinguishable from changes in community structure or prey availability that might occur naturally. The relative impact of fisheries perturbations, compared to broad, regional events such as climatic shifts, are uncertain; but given the potential importance of localized prey availability for foraging marine mammals, they warrant close consideration.

Lowry (1982) developed qualitative criteria for determining the likelihood and severity of biological interactions between fisheries and marine mammal species in the Bering Sea. His criteria were based on marine mammal diet, focusing on species consumed, prey size composition, feeding strategy, and the importance of the Bering Sea as a foraging area.

As with other apex predators such as Steller sea lions, ecological interactions between northern fur seals and the groundfish fisheries may be caused by spatial and temporal overlap between fur seal foraging areas and groundfish fisheries and from competition for target and bycatch species taken by the fisheries. Therefore, a potential mechanism by which fur seals may be disadvantaged by competition with commercial fisheries for food resources is through competition or localized depletion of prey. Whereas the overall abundance of prey across the entire Bering Sea may not be affected by fishing activity, reduction in local abundance, or dispersion of schools could be more energetically costly to foraging marine mammals. Thus, the timing and location of fisheries, relative to foraging patterns of northern fur seals may be a more relevant management concern than total removals. Such a case for concern over possible localized depletion has been identified for Steller sea lions and the groundfish fisheries in the BSAI and GOA for walleye pollock, Pacific cod and Atka mackerel. The diet of northern fur seals includes a wide range of fish species, with less apparent dependence on Pacific cod and Atka mackerel compared to Steller sea lions. However, both adult and juvenile pollock occur in the diet of northern fur seals and consumption rates vary according to the abundance of different age classes of pollock in the foraging environment

(Swartzman and Haar, 1983; Sinclair *et al.,* 1996). Evaluation of the indirect effects of fisheries on northern fur seals, stemming from the various alternatives, therefore, focuses less on removals of Pacific cod and Atka mackerel and more broadly on removals of pollock and small schooling fishes.

Northern fur seals forage at shallow to mid-water depths of 0 to 820 ft (0-250 m), both near shore and in pelagic regions of their migratory range. Female and young male fur seals generally consume juvenile and small-sized (2 to 8 inch) schooling fishes and squids although diet varies across oceanographic subregions along their migration routes and around breeding locations in the Pribilof Islands. In the eastern Bering Sea, primary prey species include pollock and Pacific cod, but deep sea smelts, lanternfish, and squids are also major components. Recent studies based on scat analysis have indicated that the pollock and Pacific cod consumed by fur seals tend to be smaller than those selected by the target fisheries, however data from stomach collections from the 1960s through the 1980s indicate that fur seals often consume adult pollock. Recent studies used bio-chemical methods to study the diet of northern fur seals suggests that the diet of deep diving fur seals in waters over the continental shelf includes adult pollock (Kurle and Worthy, 2000). Thus, the most relevant indirect effects of the alternatives on northern fur seals are likely to be those that either increase or decrease the abundance or distribution of smaller schooling fishes and squid, or shift the overall pattern of pollock and Pacific cod harvest in a manner that changes the harvest rate of fur seal prey.

(iii) Effects of Commercial Fishing on Fisheries Harvest of Prey Species of Northern Fur Seals

Management actions under the current BSAI FMP, specific to the protection of northern fur seals, have not been addressed directly. Trawl closures around the Pribilof Islands, established mainly for the protection of crab stocks, may offer positive benefits for fur seals by limiting prey removals in waters surrounding the Pribilof Island rookeries. However, only northern fur seals foraging close to the islands would benefit by the availability of an undisturbed prey field and recent tracking studies show that foraging trips of both adult female and juvenile male fur seals extend well beyond the trawl closure boundaries. Recent satellite telemetry data on the foraging locations of northern fur seals allows for analysis of fur seal foraging locations at finer scales of resolution. Areas closed to fishing in the EBS include habitat used by foraging fur seal females breeding on the Pribilof Islands. This includes the waters north of Unimak Pass and on the shelf to the east of the Islands in the Pribilof Islands Conservation Area . The partitioning of foraging habitat by lactating fur seals on the Pribilof Islands (Figure 3.1.4-1) indicates that the Pribilof Islands Area Habitat Conservation Zone would primarily benefit females from northeast St. Paul Island and provide less protection to the foraging habitat of females from southwest St. Paul Island or St. George Island.

The size of the fish removed and whether the bycatch of squid, small schooling fish, pollock, and Pacific cod are a large fraction of their estimated biomass in the Bering Sea must be considered in determining if the harvest could have significant effects on the population. Catches of squid and small schooling fish (e.g., fish designated in the forage fish assemblage) in the groundfish fisheries of the BSAI are low, generally less than 1,000 mt per year. While precise biomass estimates for these groups do not exist, the exploitation rate on these groups in the groundfish fisheries is also thought to be very low. For instance, squid biomass in the Bering Sea may be as large as 4 million mt, based on marine mammal food habits, daily ration, and abundance data (Sobolevsky, 1996). Similarly, with respect to small schooling fishes, consumption of capelin in the Gulf of Alaska by arrowtooth flounder alone may be as large as 300,000 mt per year (Livingston, 1994). Assuming that these crude projections of squid and capelin biomass at least approximate the order of magnitude of the true population levels, then the fisheries removals would amount to only a fraction of 1 percent of those populations.

Fisheries for pollock do not target fish younger than 3 years of age (Ianelli et al., 1999; Dorn et al., 1999; Thompson and Dorn, 1999; Thompson and Zenger, 1994; Fritz, 1996). The overall catch of pollock smaller than 30 cm is small, and thought to be only 1 to 4 percent of the number of one- and two-year olds each year in the eastern Bering Sea and GOA (Fritz, 1996). However spatial and temporal patterns in the bycatch of juvenile pollock in the Bering Sea may influence the rate of removals in areas where northern fur seals forage. Exploitation rates of 2-3 year old pollock ranged between 11% and 21% from 1973 to 1979 during the period when the foreign fishery in the eastern Bering Sea operated northwest and west of the Pribilof Islands (Fritz, 1996). Seasonally, the highest bycatch of small pollock occurs during early summer (May-July) when spawning aggregations have dispersed and pollock are generally less segregated by size (Fritz, 1996). Data on the consumption rate of adult pollock by northern fur seals is inconclusive. Analysis of data from stomach collections (e.g., Swartzman and Haar, 1983; Sinclair et al., 1994) indicate that fur seals may consume adult pollock when it is available in the foraging environment , whereas studies based on scat analysis show a diet consisting of primarily of juvenile pollock (e.g. Sinclair et al., 1996; Antonelis *et al.,* 1997). Carbon and nitrogen isotope analysis of fur seal tissues suggests that the diet of lactating females includes prey at trophic levels equivalent to 2 - 4 year-old walleye pollock and small Pacific herring during the fall (Kurle and Worthy, 2000). Fatty acid analysis of milk samples from lactating fur seals consistently diving to depths greater than 328 ft (100 m) in outer continental shelf waters of the Bering Sea had fatty acid signatures most similar to fatty acid signatures of walleye pollock. In waters over the continental shelf, adult walleye pollock are generally found near the bottom while juvenile pollock are usually concentrated in the surface layer above the thermocline (Bailey, 1989) suggesting that the diet of deep diving fur seals in these areas includes adult pollock.

Therefore, while fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), competition due to the harvest rates of those species may vary depending on the size range consumed by fur seals. The overall catch of juvenile pollock has tended to be low in recent years and the degree to which adult pollock occur in the northern fur seal diet is not certain. While the potential overlap with fisheries may be moderated by these factors, effects on northern fur seals may yet exist, the relevance of which is not reflected by estimates of biomass removals over large geographical areas.

(iv) Effects of the Spatial and Temporal Concentration of Fisheries on Northern Fur Seals

The competitive overlap between fisheries for Pacific cod and pollock and northern fur seals is influenced by several factors determining whether removals are concentrated in space or time. First, to the degree that the size of fish targeted by the fishery is greater than that generally eaten by fur seals, competition may vary depending on the availability of smaller prey in foraging areas. Second, 45% of the catch from both fisheries occurs during the A season in winter when female and juvenile male fur seals are not commonly found in the areas used by fisheries in the Bering Sea or the GOA. Third, during the summer, fishery harvest rates on adult pollock and Pacific cod in areas used by fur seals are below the annual target rates for the fish stocks as a whole. For instance, in the EBS west of 170°W, pollock harvest rates in the summer have averaged less than 5% since the early 1980s (environmental assessment for pollock RPAs). Pacific cod harvest rates in the same area and time have been less than 1% since 1996. Fourth, under Alternative 1, the summer pollock fishery in the

Bering Sea begins on September 1, which reduces the temporal overlap between the pollock fishery and the fur seal breeding season (June-October).

While these factors lower the probability of adverse impacts stemming from spatial or temporal concentration of fisheries in northern fur seal foraging areas, changes in harvesting activity and/or concentration of harvesting activity in space and time may differentially impact fur seal foraging habitat at both the population and sub-population level.

During 2001-2002 the proportion of total June-October catch in fur seal meta-home ranges increased from 47% in 1998 to 64% in 2000. This reflects a change in the impact on northern fur seal foraging habitat. For example, the proportions of total June-October pollock catch in fur seal foraging habitat (defined as the combined meta-home ranges for females from St. Paul and St. George islands, Fig.4.1) increased from an average of 40% in 1995-1998 to 69% in 1999-2000 (Figure 4.2). The shift in the distribution of fishing effort (Fig. 4.3) may have been due, in part, to trawl closures to protect Steller sea lion foraging habitat implemented during 1999 and 2000; the proportion of pollock catch in Steller sea lion critical habitat decreased from an average of 44% to 16% in the same period. Increases in the catch of EBS pollock may represent potential increases in competition, because pollock represents 34% to 80% of northern fur seal diet in the Bering Sea. Increased catches of other prey items such as Pacific cod, Atka mackerel, and rockfish may be of less consequence, because they comprise less than 5 % of fur seal diet. From 1995-99 the proportion of the summer pollock catch removed from the meta-home range of lactating fur seals from St. George Island was consistently higher than the catch in foraging areas used by St. Paul Island females (Figure 4.1).

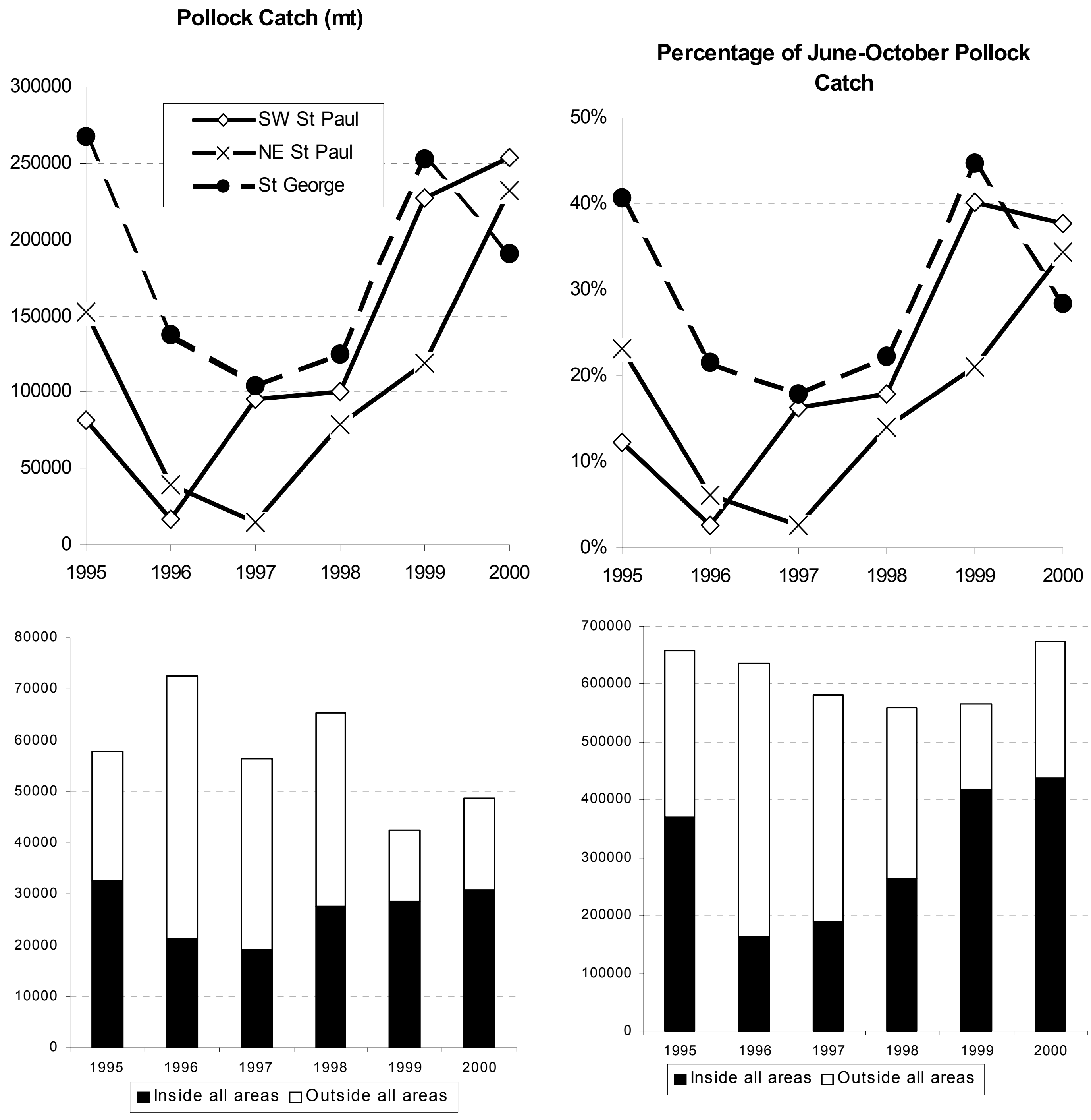
This overlap was emphasized with a shift in the pollock fishery between 1999 and 2002 (NMFS 2003). During this period the fishery in the Bering Sea moved to within 20 nm of Dalnoi Point, a Steller sea lion haulout, on the southern edge of St. George Island. As a result, significant increases in pollock catch occurred within 10 nm of the haulout during 2001 and 2002. The amount of pollock caught in 1999 inside of 20 nm from St. George Island increased from 3,736 mt to over 30, 239 mt caught within 20 nm of the point in 2002. This amount of pollock represented over 2 percent of the entire TAC for the Bering Sea being caught within 20 miles of one Steller sea lion haulout and the fur seal rookeries on St. George Island, and an order of magnitude increase in the amount of pollock taken from this one location. This increase is one of the principal reasons for the conditionally adverse cumulative effect determination of the commercial fishery on fur seals.

The smaller size of the population in conjunction with a higher rate of decline in pup production on St. George Island in recent decades suggests that the impact of the pollock fishery in this area on the foraging habitat of St. George Island females should be considered. Given the uncertainty in the degree to which fur seals compete with the fishery for adult pollock in fur seal foraging areas where spatial and temporal overlap has been identified, it is assumed that conditionally significant negative effects could occur.

Table 4.1 Summary of incidental mortality of northern fur seals (Eastern Pacific stock) due to commercial fisheries from 1990 through 2001 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from self-reported fisheries information. Data from 1997 to 2001 (or the most recent 5 years of available data) are used in the mortality calculation when more than 5 years of data are provided for a particular fishery. n/a indicates that data are not available.

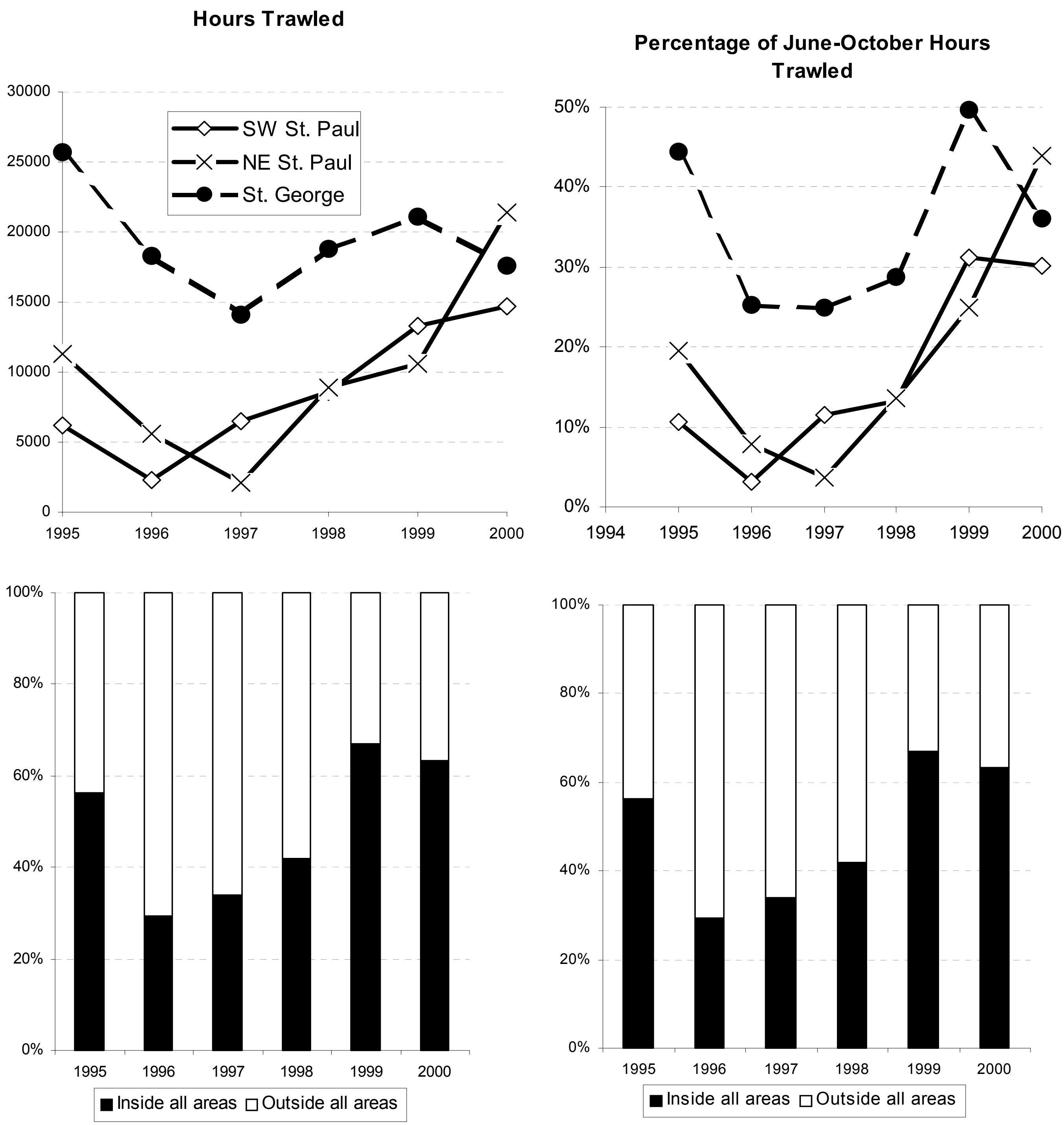
Fishery name	Yr	Data type	Range of obsr covrage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Islands groundfish trawl	1997-2001	obs data	53-74%	0, 1,1, 0, 1	0, 4,2,1, 2	1.5 (CV = 0.13)
Observer program total						1.2 (CV = 0.63)
				Reported mortality		
Prince William Sound salmon drift gillnet	1990-2001	self rpts	n/a	1, 1, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Alaska Peninsula/Aleutian Islands salmon drift gillnet	1990-2001	self rpts		2, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥0.5]
Bristol Bay salmon drift gillnet	1990-2001	self rpts	n/a	5, 0, 49, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[≥13.5]
Minimum total annual mortality						≥15.7 (CV = 0.63)

Figure 4.1 Total catch of pollock during the summer and fall fishery in the eastern Bering Sea



Note: Upper panels show the total catch and percentage of catch for meta-home range area from southwest St. Paul Island, northeast St. Paul Island, and St. George Island. Lower panels show the total catch inside and outside all areas combined.

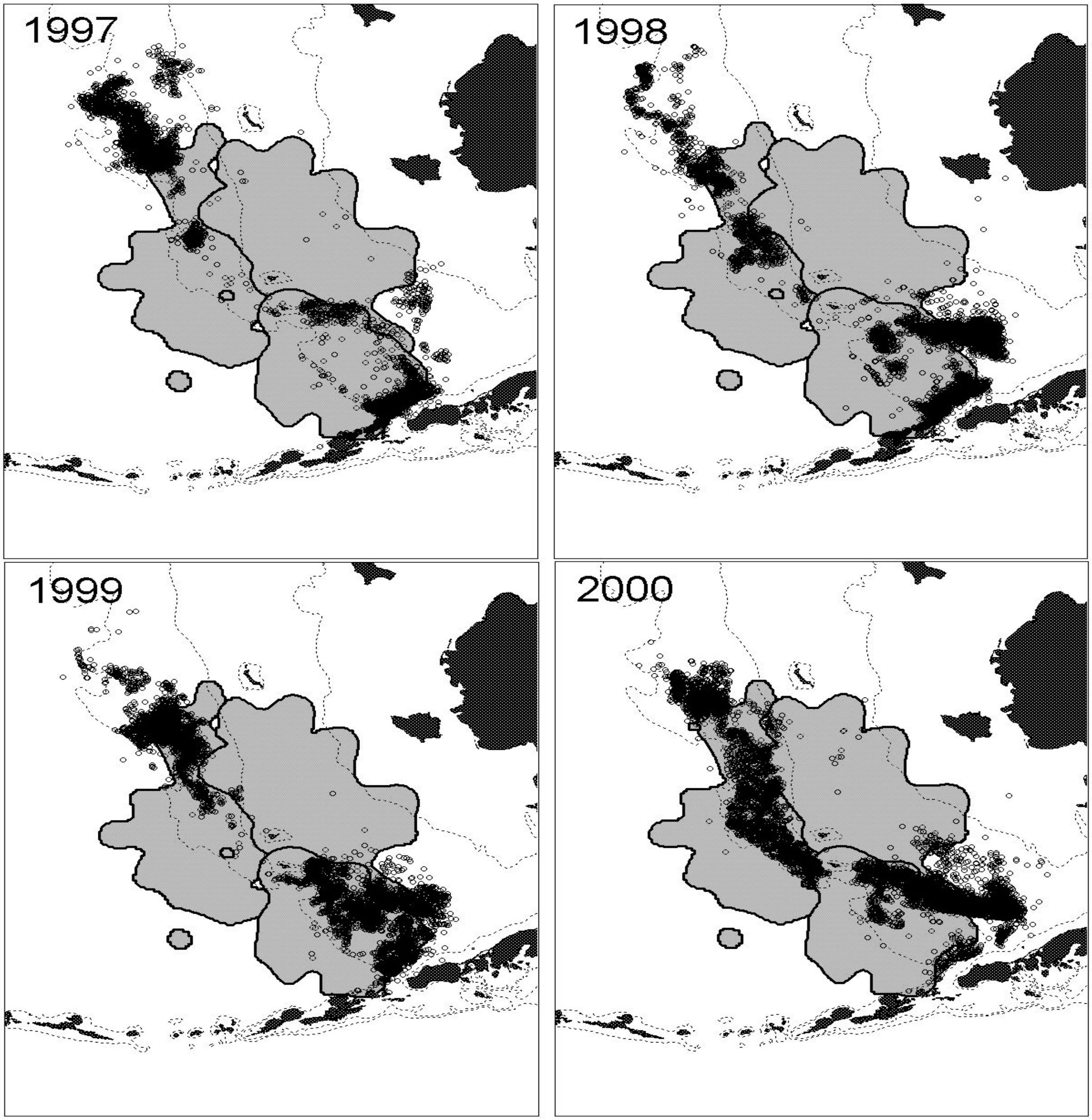
Figure 4.2 Hours trawled during the summer and fall Pollock fishery in the eastern Bering Sea



Note: Upper panels show the hours trawled and percentage of hours trawled for meta-home range areas from southwest St. Paul Island, northeast St. Paul Island, and St. George Island. Lower panels show the total catch inside and outside all areas combined.

Figure 4.3 Location of trawls (circles) during the summer-fall eastern Bering Sea pollock Fishery in 1997-2000.

.



Source: The grey shaded areas show the meta-home range areas (see Figure 3.1.4-1) for lactating northern fur seals from St. Paul and St. George islands based on satellite telemetry data from 1995 and 1996 (Robson 2001).

(v) Effects of fishing on short term/local prey availability

Competition has been defined in many ways. Although the various definitions have important differences, each definition has two basic elements (a) competition occurs between two or more individuals (or populations) that actively demand a common resource and, (b) in meeting those demands, reduce a resource's availability to other individuals or populations or that the resource is in short supply relative to the number seeking it. We will evaluate the information available to determine if it allows us to conclude that the fisheries compete with Steller sea lions.

The data necessary to resolve whether groundfish fisheries of the BSAI and GOA compete with listed species is sparse. First of all, we do not have comprehensive information on the structure and composition of the marine ecosystem before commercial exploitation of fisheries began, nor do we have information on the population cycles of fish, marine mammals, and seabirds over long periods of time that would provide a solid foundation for this type of analysis. Nevertheless, these effects are not merely theoretical; competition between fisheries, marine mammals, and seabirds have been observed worldwide. Based on these studies we believe competition could exist between groundfish fisheries, marine mammals, and seabirds in the BSAI and GOA.

Competition between the groundfish fisheries and non-human predators in the marine ecosystem of the BSAI and GOA can occur at different spatial and temporal scales. At the macro-scale, potential impacts of fishing include competition for a common resource and/or shifts in predator prey relationships resulting from direct mortality and by shifts in the carrying capacity. These impacts are superimposed on a natural system that is fluctuating due to external forcing at the seasonal, interannual and interdecadal time scales. Differentiating fishery induced shifts in fish distribution from natural shifts due to changes in oceanographic conditions is an active field of research in the marine community. At current harvest levels, the impacts of commercial harvest on the macro-scale distribution of walleye pollock and Pacific cod are not easy to distinguish.

Competition can also occur on a meso-scale if the fisheries affect the distribution or abundance of groundfish in a region (such as Shelikof Strait or Bristol Bay). Finally competition can occur on a micro-scale if fishing vessels affect the distribution and abundance of groundfish in specific locations. With decreasing spatial scale, there is a corresponding decrease in the temporal dynamics of competition: the effects of fisheries on the distribution and abundance of fish species have shorter duration as spatial scales decreases.

(vi) Depletion of Resources

Marine consumers deplete the biomass of their prey on local scales. Although reductions in biomass at these spatial scales have the shortest duration, they can affect the foraging success of other, individual consumers of the prey species. In 1963, Ashmole suggested that seabirds could deplete the prey base around their nesting colonies, which would reduce the supply of food available to the entire colony and reduce breeding success by limiting food available to fledglings. Ashmole (1963) called this depletion a "halo" around the colony that contained low densities of prey. Furness (1984) concluded that seabirds can consume almost one-third of the pelagic fish production within 45 kilometers of their nesting colonies, which would place them in competition with commercial fisheries, predatory fish, and marine mammals if they consumed the same sizes of prey. Seabirds in colonies along coastal Oregon can consume as much as 22 percent of the fish production around their colonies. Vessel traffic alone may temporarily cause fish to compress into tighter deeper schools or split them into smaller concentrations (Laevastu and Favorite 1988). The passage of one trawl through a school of Pacific whiting was found to create a "hole" in the school due to removal of fish and their avoidance of the gear (Nunnallee 1991). In this study, the school structure returned to its pre-disturbance shape and density within tens of minutes after a vessel moved through a school. Repeated trawling by many vessels over several days on fish school structure could make them scatter. Most importantly it could affect foraging at a local level, although the extent of this effect is not known.

(vii) Regional-scale localized depletions of groundfish

As in the above cases, fishing may hasten the decline of stocks that are already declining due to natural reasons. Shelikof Strait pollock is an example of this phenomenon (Fritz et al. 1995, National Research Council 1997). A fishery developed after a large spawning aggregation was discovered in the Strait in the late 1970s. Pollock catches in the Gulf of Alaska increased from less than 100,000 metric tons to more than 300,000 metric tons, although harvest rates remained essentially constant and at what was considered a sustainable level. Because of declining recruitment and fishing removals, the exploitable biomass of pollock in the GOA declined from 3 million tons in 1981 to less than 1 million in 1993 (NPFMC 1993).

Localized depletions associated with the Atka mackerel fishery based on in-season changes in CPUE of the Atka mackerel fishery were identified at three BSAI locations (Seguam Bank, Petrel Bank, and Kiska Island) and one location in the GOA from 1992 to 1995. During a review of these fisheries, it was recognized that rates of removal exceeded rates of immigration. Comparing biomass estimates between years, it became apparent that temporary reductions in the sizes of local Atka mackerel populations could affect other Atka mackerel predators, such as the Steller sea lions. Subsequent Leslie depletion analyses were completed for 37 time-area fisheries in 1986-97. The areas analyzed included east and west of Buldir Island, west of Kiska Island, two areas south of Amchitka Island, north of the Delarof Islands, the east side of Tanaga Pass, and south of Seguam Island. With an alpha value of 0.05, a total of 17 of the 37 time-area fisheries yielded statistically significant relationships between cumulative catch and CPUE. The CPUE increased significantly in one case and declined significantly in 16 cases. In general, the greater the total catch in an area, the more likely CPUE declined significantly.

These assumptions appeared to be reasonable for the Atka mackerel fish stock in the central and western Aleutian Islands. Mackerel are found in well-defined habitat and the fishery operates at relatively constant locations. The duration of the fishery is relatively short so that natural mortality and migration into and out of the fish stocks are likely limited. Catchability could change over the course of the fishery, but if such changes occur, say as a result of dispersion or altered schooling behavior, those changes could also have detrimental affects on foraging sea lions. Finally, the use of CPUE as direct measure of fish density or abundance has problems, but CPUE is commonly used as a reliable index of density or abundance.

(viii) Disturbance to groundfish schooling patterns caused by fishing

With respect to pinnipeds, the issue of disturbance of foraging patterns has been closely related to the issue of temporal concentration of the fisheries. The concentration of fishing effort into short periods of time may increase the likelihood or intensity of disturbance during the fishery, followed by a period of relatively little or no disturbance. On the other hand, fisheries that are broadly distributed over time may cause a low, but prolonged, level of disturbance. Because temporal concentration may have greater significance in terms of creating localized depletions of prey, new management measures have emphasized the need to disperse the fisheries over time.

The potential for disturbance or interference competition may be more significant when prey resources are concentrated in a small area over a short period of time. This is evident in the case history of the Steller sea lion issue in the BSAI. Current fishery management measures do not assume that disturbance effects from fishing on foraging efficiency of Steller sea lions are negligible. The rationale behind dispersal of catch and effort in space and time was intended to both decrease the likelihood of localized depletion and reduce the local intensity of fishing (and its disturbance). The level of potential competition, and the effects of vessels in, and around, foraging sea lions, seems to be variable. Such an overlap of foraging and fishing activity has also been demonstrated for fur seals.

4.5.3.2 <u>Potential Indirect Effects of the Environment on Fur Seals in the BSAI</u>

NMFS recognizes that natural phenomena and many human activities have contributed to the current declining status of populations of species in the BSAI and EBS. This section summarizes the principal natural phenomena and human-related activities in the action area that are either occurring, or have occurred, and are believed to affect habitat and also the likelihood that several species including fur seals will survive and recover in the wild. To prepare this section, NMFS relied on numerous published documents; environmental impact statements prepared by NMFS and the Department of the Interior's Minerals Management Service; annual Stock Assessment for Fisheries Evaluation (SAFE) reports for the groundfish fisheries of the BSAI, and GOA; documents that have been transmitted with annual SAFE reports since 1995; biological opinions prepared on Federal activities in the action area; and detailed information on the ecology of this region provided in reports prepared for the Minerals Management Service's Outer Continental Shelf Environmental Assessment Program; NMFS (2001) Ackley et al. (1995), Bakkala (1993), Hood and Calder (1981), Hood and Zimmerman (1986), Loughlin and Ohtani (1999), and the National Research Council (1996).

(i) Effects of Global Climate Change

The coming era could be unique because there has been a new long-term global force applied to the Earth's climate in the twenty-first century, which may superimpose a warming trend upon the ongoing large regime shift effects. The effects of greenhouse gases accumulating in the atmosphere during the twentieth century is beginning to be manifest as a small rise in average global temperature, which is expected to continue even as the input of such gases is diminished. Based on the relatively crude climate change scenarios predicted by the scientific community, experiments were performed at a GLOBEC workshop (1996) to estimate changes for the subarctic North Pacific Ocean in general. Based on these experiments, coming changes can be estimated for the BSAI and GOA. However, these are only speculations.

Climatologists start with the assumption of a secular warming of the atmosphere over the North Pacific Ocean, especially at higher latitudes. The more rapid rate of warming to the north would serve to decrease the meridional thermal gradient and cause a more sluggish atmospheric circulation. Major overall weather effects would be an increase in absolute humidity, a decrease in storm intensity, and a northward shift in the storm track. The humidity increase would increase coastal precipitation. Major ocean circulation effects would follow the northward shift in the average line of zero wind stress curl which separates the subarctic and subtropic gyres. These effects are that the core of the eastward-flowing West Wind Drift would weaken and shift to the north, where it bifurcates into the Alaska Coastal and California Currents would also shift to be north. Changes in these features imply changes for the BSAI.

(ii) Atmospheric and Oceanic Changes in the BSAI

Effects of a global warming climate should be greater in BSAI than in the GOA. This is because the BSAI is farther north, where warming is expected to be greater due to the less snow cover and sea ice, hence a lower albedo. Atmospheric changes that drive the speculated changes in the ocean include increases in air temperature, storm intensity, storm frequency, southerly wind, humidity, and precipitation. The increased precipitation, plus snow and ice melt, lead to an increase in freshwater runoff. The only decrease is in sea level pressure, which is associated with the northward shift in the storm track. Although the location of the maximum in the mean wind stress curl will probably shift poleward, how the curl is likely to change is unknown. The net effect of the storms is what largely determines the curl, and there is likely to be compensation between changes in storm frequency and intensity.

Ocean circulation decreases are likely to occur in the major current systems: Alaskan Stream, Near Strait Inflow, Bering Slope Current, and Kamchatka Current. Competing effects make changes in the Unimak Pass inflow, the shelf coastal current, and the Bering Strait outflow unknown. Changes in hydrography should include increases in sea level, sea surface temperature, shelf bottom temperature, and basin stratification. Decreases should occur in mixing energy and shelf break nutrient supply, while competing effects make changes in shelf stratification and eddy activity unknown. Ice extent, thickness, and brine rejection are all expected to decrease.

(iii) Regime Shift Hypothesis

The North Pacific Ocean is dominated in the winter by an atmospheric phenomenon called the Aleutian Low. The Aleutian Low is a semi-permanent low pressure area that develops late in the year, dominates the winter, and begins to break down during the spring to be replaced by an extensive high pressure system during the summer (Beamish 1993). It can produce changes in atmospheric temperature, storm tracks, ice cover, and wind direction in the BSAI, and GOA (Wyllie-Echeverria and Wooster 1998). Short-term El Niño Southern Oscillation events intensify the Aleutian Low Pressure cell, which enhances wind forcing and precipitation in the North Pacific. This increases the advection of warm water into the northern region of the North Pacific Ocean, increases sea surface temperatures in the BSAI, and GOA, and can trigger a series of oceanographic events that increase ocean productivity. These events cause the marine ecosystems of the BSAI, and Gulf of Alaska to oscillate between "warm" climatic regimes and "cold" climatic regimes (Ebbesmeyer et al. 1991, Brodeur and Ware 1992, Beamish 1993, Francis and Hare 1994, Miller et al. 1994, Trenberth and Hurrell 1994; Ingraham et al. 1998).

From 1940-1941 an intense Aleutian Low was observed over the BSAI, this was followed recently from December 1976 to May 1977 with an even more intense Aleutian Low. During this latter period, most of the North Pacific Ocean was dominated by this low pressure system which signaled a change in the climatic regime of the BSAI. The system shifted from a "cold" regime to a "warm" regime that persisted for several years. Since 1983, the GOA and Bering Sea have undergone different temperature changes. Sea surface temperatures in the Bering Sea were below normal. Recent evidence now indicates that another regime shift occurred in the North Pacific in 1989.

(iv) Impacts on Biological Productivity and Animal Populations

Most scientists agree that the 1976/77 regime shift dramatically changed environmental conditions in the BSAI. However, there is considerable disagreement on how and to what degree these environmental factors may have affected both fish and marine mammal populations. Productivity of the Bering Sea was high from 1947 to 1976, reached a peak in 1966, and declined from 1966 to

1997. Some authors suggest that the regime shift changed the composition of the fish community and reduced the overall biomass of fish by about 50 percent (Merrick et al. 1995, Piatt and Anderson 1996). Other authors suggest that the regime shift favored some species over others, in part because of a few years of very large recruitment and overall increased biomass (Beamish 1993, Hollowed and Wooster 1995; Niebauer and Hollowed 1993, Wespestad et al. 1997, Wyllie-Echeverria and Wooster 1998).

(v) Impacts on Fur Seal Foraging Habitat

More information is available on fur seals and Steller sea lions than any other marine mammal species in the area. Therefore, a discussion on the impacts of climate variability and regime shifts on the forage species necessarily focuses on these two species.

One hypothesis is that during regime shifts, certain species flourish, such as walleye pollock and Pacific cod, at the expense of other prey species (i.e, forage fishes). NMFS believes that the situation is much more complicated than this. First, from 1970 to 1980, the annual groundfish catch in the BSAI and GOA ranged from 1.3 to 2.3 million mt, very close to the current catch levels. During the same period, the catch of walleye pollock ranged from 1.0 to 1.9 million mt, which comprised about 70 to 83% of the total groundfish catch. The highest groundfish catch during this period was 2.3 million mt in 1972, of which the pollock catch was 1.9 million mt or 83% of the total.

Second, catches of pollock spawned before the regime shift were high. For example, in the GOA, the catch-per-unit-effort of walleye pollock increased by 6 times from 1961 to 1973-1976 (Ronholt et al. 1978). The greatest increases (about 17 times) were observed in Prince William Sound and around Kodiak Island. Ronholt et al. concluded that the biomass of walleye pollock had increased from 15.9 kilograms/hour to 320.5 kilograms/hour between the 1960s and early 1970s. Megrey and Wespestad (1990) estimated the total biomass of walleye pollock in the action area at around 12 million mt in 1971 and 1972, which fell below about 10 million mt after 1975 (except for 1982).

The data presented here suggest that walleye pollock comprised the majority of groundfish catches in the BSAI and GOA for almost a decade before the regime shift. Although catch is not always a reliable proxy for biomass, given the magnitude of the catches in the late 1960s and 1970s, it does indicate that the pollock biomass had been fairly substantial. In the annual SAFE document (NMFS 1999), NMFS has used models to hindcast back into the 1970s to estimate pollock biomass. However, due to inconsistent survey methodology and the lack of reliable commercial data, NMFS considers those estimates to have very large confidence bounds. For example, in the SAFE NMFS has estimated the pollock biomass in the early 1970s to be about 2 million mt, yet the catch from 1972 alone was 1.9 million mt). These estimates are obviously questionable since it is inconceivable that the fishery caught nearly every fish, and then in 1973 caught another 1.8 million mt of pollock. It is unclear if these catches would have been sustainable in the long term (i.e., it is possible that overfishing was occurring). This supports the argument that pollock biomass was substantial before the regime shift, and that our current estimates of that biomass may not be accurate due to limitations in the available data.

While biomass was high before the regime shift, it is also reasonable to conclude that the 1976-1977 regime shift produced some very large year-classes of gadids (walleye pollock and Pacific cod). At the same time, the regime shift produced large year classes of other groups, including salmonids (Pacific salmon), clupeids (Pacific herring), scorpaenids (sablefish, Pacific ocean perch, and other rockfish), anoplomatidae (sablefish), and pleuronectids (Pacific halibut) among others (see Beamish 1993). The effects of the regime shift on the productivity of marine species was not limited to the BSAI and GOA. Large year classes were produced as far south as California (Beamish 1993).

NMFS agrees that many competing factors have contributed to the ecosystem in which many components of the fur seal population now depend. However, the important question here is whether the diet, or some other habitat need, of fur seals was adversely affected by the regime shift. It seems unlikely that Steller sea lions would respond to a regime shift with population declines of 80% or more, particularly given the fact that we believe regime shifts happen at 30 to 50 year intervals. It is unreasonable to expect this species to recover quickly after each regime shift. It is important to note that NMFS does not suggest that regime shifts would not cause Steller sea lions to decline at all, rather, that declines of 80 to 90% in the face of short-term, environmental change would imply that Steller sea lions are poorly adapted to changes in their environment, after surviving for thousands of years in that environment. Fur seals have not demonstrated such declines and their history is confounded with a significant commercial harvest which affected their numbers. The current decline of approximately 4 % , however, may be as a result of a change in carrying capacity or a fisheries-influenced effect, or both in combination with other factors.

(vi) Possible Changes in the Carrying Capacity of the BSAI

Populations can experience abrupt and dramatic declines because of dramatic reductions in environmental carrying capacity (Odum 1971). Such a reduction could explain the decline of top predators in the BSAI and GOA. One hypothesis argues that the regime shift favored gadids which decreased the quality of the natural environment for pinnipeds and some seabirds, due to the lower energy content compared to herring and capelin that theoretically dominated the pelagic community during the "cold" regimes. The regime shift produced environmental conditions that increased the abundance of walleye pollock, Atka mackerel, Pacific cod and various flatfish species (Beamish 1993). After reconstructing the strength of different pollock year-classes, Beamish (1993) concluded that the 1978 year-class of walleye pollock was the strongest on record and dominated the commercial pollock catch in the 1980s. At the same time, small forage fish like capelin, eulachon, and Pacific sandlance declined in bays and the nearshore waters of the BSAI and western and central GOA (Anderson and Piatt 1996).

Other investigators suggest the regime shift caused the entire structure and composition of the invertebrate and fish communities of the region to change (Brodeur and Ware 1992, Beamish 1993, Francis and Hare 1994, Miller *et al*. 1994, Hollowed and Wooster 1992; 1995; Wyllie-Echeverria and Wooster 1998).

Conversely, the other side of this debate accepts that the climatic regime shifted in the mid-1970s and that the regime shift produced large year-classes of groundfish in 1976-1977 (NMFS 1998). This would not necessarily reduce the carrying capacity of the system for pinnipeds, such as Steller sea lions, northern fur seals, harbor seals, kittiwakes, or murres. In fact, it could possibly increase the carrying capacity. In summary, there is considerable disagreement about the effect of these oscillations on the carrying capacity (*K*) of the North Pacific. Perhaps the carrying capacity was increased for some species and decreased for others, or that the entire *K* was either decreased or increased. At this point, the best available scientific and commercial data are equivocal.

All animal populations fluctuate over time; sometimes in response to changes in their physical environment, sometimes in response to changes in their ecological relationships (predator-prey dynamics), and sometimes in response to combinations of the two. Large, natural variability often masks the effects of human activity on natural ecosystems and populations. Because of the complex relationships between wild populations, their physical environment, and their ecological relationships, it is extremely difficult to assign a populations' decline to a single cause.

Further complicating our understanding of these natural phenomena, a major expansion of the groundfish fisheries occurred in the BSAI and GOA during the 1977-1978 regime shift. As these groundfish fisheries expanded, numerous investigators expressed concern about the effects of the expanded fisheries on populations of pinnipeds and seabirds in the North Pacific Ocean (Alverson 1991, Ashwell-Erickson and Elsner 1981). Several populations of seabirds and pinnipeds including fur seals declined from the early to mid-1980s. As a result, scientists and fishery managers began to debate the relative roles of the regime shift and the groundfish fisheries on trophic relationships in the BSAI and GOA (Lowry et al. 1982, Alaska Sea Grant 1993).

(vii) Effects of Carrying Capacity (K) on Fur Seals: Few efforts have been made to assess whether the fur seal carrying capacity of the Bering Sea and eastern North Pacific ecosystem has changed. Northern fur seals were possibly near their carrying capacity between 1940 and 1956 when peak numbers of animals were seen on the Pribilof Islands. However, significant changes have taken place in the abundance and size/age-structure of fish, shellfish, seabird, and marine mammal populations (cf., Bailey et al., 1986; Bakkala et al., 1986, 1987; Springer et al., 1986; Merrick et al., 1987; Nunnallee and Williamson, 1988; Bakkala, 1989; Loughlin and Merrick, 1989; Lowry et al., 1989; Pitcher, 1990). Swartzman and Haar (1983) reviewed fisheries data for the Bering Sea (primarily on walleye pollock, Theragra chalcogramma) as it relates to carrying capacity. While their work suggests that the data are more consistent with the hypothesis that the carrying capacity has increased since the early 1970s, they "did not reject the hypothesis that the fur seal carrying capacity was reduced by fisheries." Therefore, data concerning the effects of removing fish from the Bering Sea and Gulf of Alaska on marine mammals is equivocal. The impact of commercial fishing on the ecology of fur seals and community competition is poorly understood.

Changes in environmental and oceanographic features may also influence mortality rates of fur seals and other pinnipeds, and thus influence carrying capacity. In 1950, severe storms and low temperatures were possibly responsible for an estimated 700 deaths of fur seals that were stranded in Oregon and Washington (Scheffer, 1950). York (1991) found a significant positive correlation between sea surface temperatures (SST) off British Columbia and early survival of male fur seals 4 months to 2 years old. She hypothesized-that SST may influence Pacific herring, a common fur seal prey in winter and spring), abundance and availability, thus affecting early survival of fur seals. Studies in Alaska suggest that a 1982-1983 El Nino event probably did not have an important affect on fur seals (Gentry, 1991) or some seabirds (Hatch, 1987) in that region. The same EI Nino event had a significant impact (i.e., pup production declined significantly) on the 1983 breeding season of fur seals on San Miguel Island, California (the southern extent of their North Pacific range) (DeLong and Antonelis, 1991), emphasizing the potential influence of environmental or oceanographic changes on fur seal abundance and pup production.

Therefore, a reliable measurement of the current carrying capacity for fur seals is not available, based on existing ecosystem conditions. Fowler (1986) stated that "given the available data and analyses, it is not possible to clearly determine whether the Pribilof fur seal population is currently at, above, or below carrying capacity levels; whether carrying capacity has changed significantly in the last two or three decades; or whether the observed population decline is due to declining carrying capacity, increased mortality, or some combination of both." However, it is clear, given the extreme reduction in the western population of Steller sea lions, that the environmental carrying capacity has somehow been reduced for that species and, therefore, has likely been reduced for fur seals as well. Current population trends for fur seals mimic the decline of sea lions in this area and therefore one questions whether carrying capacity for fur seals in the Bering Sea has also been diminished in recent decades.

4.5.4 Summary of Direct and Indirect Effects on Fur Seals Taking into Account the Incremental or Cumulative Impacts of Other Actions

This section summarizes the direct and indirect cumulative effects (from Chapter 4.3) of major activities on northern fur seals throughout their range. The table is taken from the Steller Sea Lion Protection Measures Final SEIS (NMFS 2001) as it is applicable to this action.

4.5.4.1 Direct Cumulative Effects

Potential Effects from the Commercial Harvest of Fur Seals: The commercial harvest of fur seals was been a major source of human-induced mortality for over 200 years, and the abundance of fur seals has fluctuated greatly in the past, largely due to this commercial harvest (NMFS 1993). Commercial harvest of fur seals peaked during 1961 with over 126,000 animals harvested, and the commercial harvest of fur seals ended in 1985 (NMFS 1993). Residual effects of past commercial harvests on the fur seal population are possible, but recent population declines have overshadowed any potential lingering residual effects. The northern fur seal was listed as a depleted stock under the Marine Mammal Protection Act (MMPA) in 1988. The reason for the listing was the steep decline in numbers (NMFS 1993). It is doubtful now whether the trends in fur seals can be attributed to the residual effects of the commercial harvest.

Direct Effects of Commercial Fishing on Northern Fur Seals

(i) Past external effects on northern fur seals due to incidental mortality in fisheries have been considerable and have contributed to population declines, especially from foreign fisheries. Present and predicted external effects include mortality sources while these animals are outside the EEZ and small levels of take in State-managed gillnet fisheries. Generally, however, the incidental take of northern fur seals is uncommon in the groundfish fisheries. The last recorded mortality in any Alaskan groundfish fishery occurred in 1996, when the take rate was one animal per 1,862,573 mt of groundfish harvested. This level of take contributes little to the northern fur seal PBR of 18,244 (Ferrero *et al.,* 2000) and is inconsequential to population trends.

Entanglement in marine debris is more common in fur seals than any other species of marine mammal in Alaskan waters (Laist, 1987, 1997; Fowler, 1988). Mortality of northern fur seals from entanglement in marine debris contributed significantly declining trends in the Pribilof Islands during mid to late 1970s and early 1980s (Fowler, 1988). The contribution of the groundfish fishery is thought to be less than in previous years and, at this time, is considered insignificant (NMFS 2001).

The potential for disturbance effects caused by vessel traffic, fishing vessels or gear, and noise appears limited for northern fur seals. Interactions with other types of fishing gear, such as trawl nets, also appear limited based on the rare incidence of takes in groundfish fisheries. Disturbance effects on northern fur seal prey are difficult to identify. Thus, a cumulative effect might be identified for disturbance but lacking information on the actual effect of disturbance, the cumulative effects was also considered unknown

4.5.4.2 Indirect Cumulative Effects

Effects of Fishing on Prey Availability: Northern fur seals are apex predators such as Steller Sea lions and as such, ecological interaction between northern fur seals and the groundfish fisheries are caused by the spatial and temporal overlap between fur seal foraging areas and groundfish fisheries and from competition for target and bycatch species. Additional information on the life history and ecology of the northern fur seal is presented in Section 3 of NMFS (2001).

Fisheries regulations implemented in 1994 (50 CFR 679.22(a)(6)) created a Pribilof Islands Area Habitat Conservation Zone, in part to protect northern fur seals. Trawl closures around the Pribilof Islands, established mainly for the protection of crab stocks, may offer positive benefits for fur seals by limiting prey removals in waters surrounding the Pribilof Island rookeries. However, only northern fur seals that forage close to the islands would benefit by the availability of prey and recent tracking studies show that foraging trips of both adult female and juvenile male fur seals extend well beyond the trawl closure boundaries. Partitioning of foraging habitat by lactating fur seals on the Pribilof Islands indicates that the Pribilof Islands Area Habitat Conservation Zone would primarily benefit females from northwest St. Paul Island and provide less protection to the foraging habitat of females from southwest St. Paul Island or St. George Island.

Effects on Prey Abundance: Since groundfish fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), competition due to the harvest rates of those species may vary depending on several factors. The potential competitive overlap between fisheries for Pacific cod and pollock and northern fur seals is influenced by several factors determining whether removals are concentrated in space or time:

- competition may vary depending on the availability of smaller prey in foraging areas.
- 45% of the catch from both fisheries occurs during the A Season in winter when female and juvenile male fur seals are not commonly found in the areas used by fisheries.
- fishery harvest rates during summer on adult pollock and Pacific cod in areas used by fur seals are below the annual target rates for the fish stocks as a whole (NMFS, 2000c).
- pollock fishery in the Bering Sea (summer season) begins on September 1, late into the fur seal breeding season (June-October).
- Fisheries for pollock do not target fish younger than 3 years of age, the preferred size by foraging fur seal (Ianelli et al., 1999; Dorn et al., 1999). The overall catch of pollock smaller than 30 cm is small, and thought to be only 1 to 4 percent of the number of one- and two-year olds each year in the eastern Bering Sea and GOA (Fritz, 1996).

While these factors lower the probability of adverse impacts stemming from spatial or temporal concentration of fisheries in northern fur seal foraging areas, changes in harvesting activity and/or concentration of harvesting activity in space and time may differentially impact fur seal foraging habitat at both the population and sub-population level. Given the uncertainty in the degree to which fur seals compete with the fishery for adult pollock in fur seal foraging areas where spatial and temporal overlap has been identified, it is assumed that conditionally significant adverse effects could occur (NMFS 2001).

The harvest of prey is considered to have cumulative impacts based on the potential overlap between fisheries and fur seal foraging habitat and based on uncertainty as to the effect of harvest on fur seal populations. This cumulative effect is considered conditionally significant adverse (NMFS 2001). Further, given the uncertainty of the effect of increased fishing in fur seal habitat during June-August (NMFS 2003), the effects of fishing were rated as conditionally significant adverse.

Catches of squid and small schooling fish in the groundfish fisheries of the BSAI and GOA are very low and are not expected to effect fur seal populations.

<u>Potential Cumulative Effects of Regime or Environmental Changes on the Northern Fur Seal</u>: The present and predicted external effects of the environment on northern fur seals and their prey associated with climate change or regime shifts are likely based on the seals' wide distribution in the BSAI and EBS which would make the susceptible to large-scale regional changes in climate. Given recent declining trends in fur seal abundance, these effects are considered conditionally significant.

Therefore, the direct and indirect cumulative effects on fur seals as a result of other activities are significant and rated as conditionally adverse. These include the potential negative effects of the environmental shifts that might affect prey or the carrying capacity of fur seals, and the effects of commercial fishing on availability of fur seal prey based primarily on the spatial and temporal overlap of the groundfish fisheries with fur seal foraging ranges, significant increases in prey removal around St. George Island, and on the lack of information from the groundfish fisheries that food availability is not related to recent population declines.

4.6 Coastal Zone Management Act of 1972

Implementation of the preferred alternative would be conducted in a manner consistent, to the maximum extent practicable, with the Alaska Coastal Management Program within the meaning of Section 30 (c) (1) of the Coastal Zone Management Act and its implementing regulations.

4.7 Regulatory Impact Review

The requirements for all regulatory actions specified in Executive Order (E.O.) 12866 are summarized in the following statement from the order:

> In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.
>
> E.O. 12866 requires that the Office of Management and Budget review proposed regulatory programs that are considered to be "significant." The preferred alternative is not considered a "significant regulatory action" because it does not: (1) have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities; (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of

Table 4.2 Direct and Indirect Effects on Fur Seals Taking into Account Incremental or Cumulative Impacts of Other Activities	
Activity	**Description of Effect on Fur Seal Stock or Habitat**
DIRECT	
Commercial Fur Seal Harvest	S- Historically Significant Adverse - resulted in Depleted Determination
On-land Natural Mortality (pup mortality at rookery)	I
Commercial Fishing Direct Effects	
Incidental Take in Fisheries	I
Entanglement in Debris	U Historically has been high but at present is considered insignificant
Disease and Parasites	I
Predation	U Recent declines in EBS pinniped and relationship to predation by killer whales is unknown
INDIRECT	
Commercial Fishing	
Disturbance due to Fishing	I
Harvest of Fur Seal Prey and prey availability to fur seals	CS- Commercial fisheries target pollock a principal prey of fur seals
Spatial/Temporal Effects of Fishing-localized Effects	CS- /S- Overlap between commercial fishing and foraging areas of fur seals in past two years has increased by several orders of magnitude around St. George
Environmental Effects	
Impacts of Environmental Shifts on Foraging Habitat	CS- Fur Seal Stock is in decline and its relationship to recent environmental regime shifts is considered significant
Regime Shift - Effects on Carrying Capacity	CS- Recent trends in fur seals and Steller sea lions indicate that carrying capacity for these species has declined from historical highs
S = Significant, CS = Conditionally Significant, I = Insignificant, U = Unknown, + = positive, - = negative	

entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or (4) raise policy issues arising out of the President's priorities or the principles set forth in this Executive Order. Based on these criteria, NMFS determines that the preferred alternative is not significant for purposes of E.O. 12866.

The Regulatory Impact Review is also designed to provide information to determine whether the proposed regulation is likely to be "economically significant." The preferred alternative is not considered to have a significant economic effect since it does not result in any of the impacts described above.

4.8 Effects of Non-consumptive Resource Use

While no market exists within which CI beluga whales are "traded" (in the traditional economic sense), they nonetheless have had economic value to a few subsistence users. They also have a large cultural value to Alaska Natives, as well as a large non-consumptive value to the non-Native public. In general, it can be demonstrated that society places economic value on (relatively) unique environmental assets, even if those assets are never directly exploited. That is, for example, society places real (and measurable) economic value on simply "knowing" that, in this case, CI beluga whales are flourishing in their natural environment.

Substantial literature has developed which describes the nature of these non-use values to society. In fact, it has been demonstrated that these non-use economic values may include several dimensions, among which are "existence" value, "option" value, and "bequest" value. As the respective terms suggest, society places an economic "value" on, in this case, the continued *existence* of beluga whales in CI; society further "values" the *option* it retains through the continued existence of the resource for future access to the CI beluga whale population; and society places "value" on providing future generations the opportunity to enjoy and benefit from this resource. These estimates are additive and mutually exclusive measures of the value society places on these natural assets, and are typically calculated as "willingness-to-pay" or "willingness-to-accept" compensation (depending upon with whom the implicit ownership right resides) for non-marginal changes in the status or condition of the asset being valued.

Quantitatively measuring society's non-use value for an environmental asset (e.g., beluga whales), is a complex but technically a feasible task. However, in the current situation, an empirical estimation of these values is unnecessary, because the MMPA and the ESA implicitly assume that society automatically enjoys a *"net benefit"* from any action which protects marine mammal species (including the habitat they rely upon), and/or facilitates the recovery of populations of such species (or their habitat). Therefore, it is neither necessary nor appropriate to undertake the estimation of these benefits. It is sufficient to point out that these very real "non-use" values to society from conservation measures for CI beluga whales do exist. Therefore, the effect of implementing the preferred alternative is likely to produce an overall net social and economic benefit.

4.9 Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA), first enacted in 1980, was designed to place the burden on the government to review all regulations to ensure that, while accomplishing their intended purposes, they do not unduly inhibit the ability of small entities to compete. The RFA recognizes that the size of a business, a unit of government, or nonprofit organization frequently has a bearing on its ability to comply with a federal regulation. Major goals of the RFA are: (1) to increase agency awareness and understanding of the impact of their regulations on small business, (2) to require that agencies communicate and explain their findings to the public, and (3) to encourage agencies to use flexibility and to provide regulatory relief to small entities. The RFA emphasizes predicting impacts on small entities as a group distinct from other entities and on the consideration of alternatives that may minimize the impacts while still achieving the stated objective of the action.

On March 29, 1996, President Clinton signed the Small Business Regulatory Enforcement Fairness Act. Among other things, the new law amended the RFA to allow judicial review of an agency's compliance with the RFA. The 1996 amendments also updated the requirements for a final regulatory flexibility analysis, including a description of the steps an agency must take to minimize the significant economic impact on small entities. Finally, the 1996 amendments expanded the authority of the Chief Counsel for Advocacy of the Small Business Administration (SBA) to file *amicus* briefs in court proceedings involving an agency's violation of the RFA.

In determining the scope, or 'universe', of the entities to be considered in an RFA, NMFS generally includes only those entities, both large and small, that can reasonably be expected to be directly or indirectly affected by the proposed action. If the effects of the rule fall primarily on a distinct segment, or portion thereof, of the industry (e.g., user groups, geographic area), that segment would be considered the universe for the purpose of this analysis. NMFS interprets the intent of the RFA to address negative economic impacts, not beneficial impacts, and thus such a focus exists in analyses that are designed to address RFA compliance. NMFS has determined
that this final rulemaking does not have negative economic impacts to small entities as defined and, as such, an Initial Regulatory Flexibility Analysis, pursuant to 5 U.S.C. 603, is not required.

4.10 Consultation and Coordination with Tribal Governments

This final rule is consistent with policies and guidance established in the Presidential Memorandum of April 29, 1994 "Government-to-Government Relations with Native American Tribal Governments". This final rule and EIS is consistent with policies and guidance established in this Memorandum. NMFS has taken several steps to consult and inform affected tribal governments and solicit their input during development of these final regulations including the development of a co-management agreement with Cook Inlet Marine Mammal Council in 2000, 2001 and 2002.

Chapter 5 Consultation and Coordination

This action and the estimates of subsistence need contained herein are the product of annual surveys conducted by NMFS with the households of St. Paul and St. George Islands, and the Tribal Governments of St. Paul and St. George Island. The harvest process described herein have also been the product of considerable consultations and coordination between NMFS and the residents and Tribal Governments.

Chapter 6 Conclusions and Findings

This EA considers the environmental consequences of two alternatives regarding the authorization of a range of subsistence estimates for the harvest of northern fur seals for the Pribilof Islands of St. Paul and St. George, for 2003-2005. The preferred alternative (Alternative 1) would provide for the same level of subsistence takes that have been approved since 1996.

6.1 Effects of the Alternatives on the Environment

The preferred alternative will not significantly affect the stock of northern fur seals. Under this proposal the maximum number of seals taken annually would be less than 2,500 if all the allowable take were harvested. Given a minimum estimate of the northern fur seal population as approximately 800,000 individuals, the PBR for this stock of marine mammals is approximately 18,000 animals. A harvest of the proposed magnitude is significantly less than PBR. Generally the number of seals harvested per year has been less than 1,800 animals and the trend in recent years has been for fewer seals to be taken each year. This is less than 10 percent of the estimated PBR which is considered negligible under the MMPA (i.e, not signficantly different from zero).

The proposed actions would have no affect on other wildlife. The proposed action is limited to a harvest of fur seals on rookeries. No endangered or threatened species or their critical habitat will be affected by this action.

The preferred alternative would meet the documented subsistence needs of the Aleuts on St. Paul and St. George Islands and is consistent with MMPA Federal law.

The proposed actions promote cultural diversity and recognizes the importance of maintaining traditions for Alaska native groups. The proposed action does not set any precendent that could increase the subsistence hunting pressure on northern fur seals.

The preferred alternative would not have a significant impact on the general public.

The proposed actions will not cause substantial damage to the ocean or habitats. There is no incidental take of other species during the harvest. The level of harvest is not inhibiting the increase of this population.

For these reasons NMFS has determined that the selection of the preferred "status-quo" alternative (Alternative 2) action will, by itself, neither significantly impact the overall quality of the human environment or cause any adverse impacts on any wildlife species listed under the ESA or MMPA.

6.2 Summary of Effects of the Alternatives Taking into Account the Incremental or Cumulative Impacts of other Actions

The commercial harvest of fur seals has been a major source of human-induced mortality for over 200 years, and the abundance of fur seals has fluctuated greatly in the past, largely due to this commercial harvest (NMFS 1993). Residual effects of past commercial harvests on the fur seal population are possible, but recent population declines have overshadowed any potential lingering residual effects. It is doubtful now whether the trends in fur seals can be attributed to the residual effects of the commercial harvest.

The present and predicted external effects of the environment on northern fur seals and their prey associated with climate change or regime shifts are likely based on the seals' wide distribution in the BSAI and EBS which would make the susceptible to large-scale regional changes in climate. Given recent declining trends in fur seal abundance, these effects are considered conditionally significant.

The direct effect of fisheries on northern fur seals due to incidental mortality in fisheries have been considerable and have contributed to population declines, especially from foreign fisheries. Present and predicted external effects include mortality sources while these animals are outside the EEZ and small levels of take in State-managed gillnet fisheries. Generally, however, the incidental take of northern fur seals is uncommon in the groundfish fisheries. This level of take contributes little to the northern fur seal PBR of 18,244 (Ferrero *et al.,* 2000) and is inconsequential to population trends.

Entanglement in marine debris is more common in fur seals than any other species of marine mammal in Alaskan waters (Laist, 1987, 1997; Fowler, 1988). The contribution of the groundfish fishery is thought to be less than in previous years and, at this time, is considered insignificant (NMFS 2001).

The potential for disturbance effects caused by vessel traffic, fishing gear, or noise appears limited for northern fur seals. Disturbance effects on northern fur seal prey are difficult to identify. Thus, a cumulative effect might be identified for disturbance but lacking information on the actual effect of disturbance, the cumulative effects was also considered unknown

Adverse impacts stemming from spatial or temporal concentration of fisheries in northern fur seal foraging areas, changes in harvesting activity and/or concentration of harvesting activity in space and time may differentially impact fur seal foraging habitat at both the population and sub-population level. Given the uncertainty in the degree to which fur seals compete with the fishery for adult pollock in fur seal foraging areas where spatial and temporal overlap has been identified, it is assumed that conditionally significant adverse effects could occur.

The harvest of prey is considered to have cumulative impacts based on the potential overlap between fisheries and fur seal foraging habitat and based on uncertainty as to the effect of harvest on fur seal populations. This cumulative effect is considered conditionally significant adverse (NMFS 2001). Further, given the uncertainty of the effect of increased fishing in fur seal habitat during June-

August, the effects of fishing were rated as conditionally significant adverse.

The present and predicted external effects of the environment on northern fur seals and their prey associated with climate change or regime shifts are likely based on the seals' wide distribution in the BSAI and EBS which would make them susceptible to large-scale regional changes in climate. Given recent declining trends in fur seal abundance and the unknown but likely relationship between these trends and environmental changes, these effects are considered conditionally significant.

Therefore, the cumulative effects on northern fur seals as a result of other activities, when considered with the alternatives proposed by this action, are significant and rated as conditionally adverse. These include the potential negative effects of the environmental shifts that might affect prey, and the effects of commercial fishing on availability of fur seal prey based on the overlap of the groundfish fisheries with fur seal foraging ranges and on the lack of information from the groundfish fisheries that food availability is not related to recent population declines

6.3 Findings

The cumulative effects on northern fur seals as a result of other activities, when considered with the alternatives proposed by this action, are significant and rated as conditionally adverse. These include the potential negative effects of the environmental shifts that might affect prey, and the effects of commercial fishing on availability of fur seal prey based primarily on the overlap of the groundfish fisheries with fur seal foraging ranges and on the lack of information from the groundfish fisheries that food availability is not related to recent population declines.

The significance effect is not based on the analysis of effects of the alternatives to set the subsistence harvest range. There is no indication that setting the subsistence harvest ranges consistent with previous years will have an adverse environmental effect. The significance determination is a result of the cumulative effects on northern fur seals of other activities, when considered with the alternatives proposed by this action, are significant and rated as conditionally adverse (from NMFS 2001).

The significant cumulative effects finding does modify or alter the previous findings or conclusions of the June 2001 Environmental Assessment prepared under NEPA for the setting of the subsistence harvest ranges for 2000-2002. Therefore, preparation of an environmental impact statement for the proposed action is required by NEPA regulations at Section 1501.4(c).

NEPA regulations at Section 1506.1 state that no action concerning this proposal can be taken until NMFS issues a record of decision which would have an adverse environmental impact or would limit the choice of reasonable alternatives. Given that the proposed alternatives in this assessment would neither have an adverse environmental impact by themselves nor would limit a range of reasonable alternatives during the development of, or prior to the completion of, the EIS required by this finding, NMFS, therefore, recommends that the preferred alternative (i.e, status-quo subsistence harvest) be allowed to proceed as NMFS prepares an EIS and issues of Record of Decision. This recommendation is consistent with NEPA regulations at 40 CFR, Parts 1506.1.

____ __________________________

Assistant Administrator for Fisheries, NOAA Date

Chapter 7 Literature Cited

Ackely, D., C. Blackburn, K. Brix, D. Clausen, J. Di Cosimo, R. Ferrero, L. Fritz, A. Grossman, J. Heifetz, P. Livingston, L.-L. Low, R. Merrick, E. Varosi, and D. Witherell. 1994. Ecosystem considerations, 1995. North Pacific Fisheries Management Council; Anchorage, Alaska.

Alaska Sea Grant. 1993. "Is it food?" Alaska Sea Grant Report, *93-1*, Alaska Sea Grant Program, 304 Eielson Building, University of Alaska Fairbanks, Fairbanks, AK 99775. p. 59.

Allen, K. R. 1980. "Conservation and Management of Whales.", University of Washington Press, Seattle, WA.

Alton, M. S., and Megrey, B. A. 1986. "Condition of the walleye pollock resource of the Gulf of Alaska as estimated in 1985." NOAA Technical Memorandum, *NMFS F/NWC-106*, U.S. Department of Commerce, NOAA.

Anderson, P.J. and J.F. Piatt. 1996. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Mar. Ecol.Progr. Series 189, pp. 117-123.

Antonelis, G. A., Sinclair, E. H., Ream, R. R., and Robson, B. W. 1997. "Inter-island variation in the diet of female northern fur seals (*Callorhinus ursinus*) in the Bering Sea." *Journal of Zoology (London)*, 242, pp. 435-451.

Antonelis, G. A., A. E. York, and C. W. Fowler. 1994. Population assessment, Pribilof Islands, Alaska. Pp. 29-47, *In* E. H. Sinclair (ed.), Fur seal investigations, 1992. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-45.

Antonelis, G. A., A. E. York, B. W. Robson, R. G. Towell, and C. W. Fowler. 1996. Population assessment, Pribilof Islands, Alaska. Pp. 9-30, *In* E. H. Sinclair (ed.), Fur seal investigations, 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-69.

Ashmole, N.P. 1963. The regulation of numbers of tropical oceanic birds. Ibis 103: 458-473.

Ashwell-Erickson, S., and Elsner, R. 1981. "The energy cost of free existence for Bering Sea harbor and spotted seals." The Eastern Bering Sea Shelf: Oceanography and Resources, in D. E. Hood and J. A. Calder, eds., Office of Marine Pollution Assessment, National Oceanic and Atmospheric Administration, University of Washington Press, Seattle, WA, pp.

Bailey, K. 1989. "Interaction between the vertical distribution of juvenile walleye pollock *Theragra chalcogramma* in the eastern Bering Sea, and cannibalism." *Marine Ecology Progress Series*, 53, pp. 205-213.

Bailey, K., R. Francis, and J. Schumacher. 1986. Recent information on the causes of variability in recruitment of Alaska pollock in the eastern Bering Sea: physical conditions and biological interactions. International North Pacific Fish. Commn. Bull. 47: 155-165.

Bakkala, R. 1989. Variability in the size and age composition of eastern Bering Sea walleye pollock,

p. 307-322 ill Proceedings of the International Symposium on the Biology and Management of Walleye Pollock, November 14-16, 1988, University of Alaska, Fairbanks, Sea Grant Report AK-SG-89-1.

Bakkala, R., T. Maeda, and G. McFarlane. 1986. Distribution and stock structure of pollock Theragra chalcogramma) in the North Pacific Ocean. International North Pacific Fish Manage. Bull. 45: 3-20.

Bakkala, R., V. Wespestad, and L-L. Low. 1987. Historical trends in abundance and current condition of walleye pollock in the eastern Bering Sea. Fish. Res. 5: 199-215.

Bakkala, R. G. 1993. "Structure and historical changes in the groundfish complex of the eastern Bering Sea." NOAA Technical Report, *NMFS 114*, U.S. Department of Commerce, NOAA. p. 91.

Beamish, R.J. 1993. Climate and exceptional fish production off the west coast of North America. Can. J. Fish. Aquat. Sci. 50:2270-2291.

Berkson, J. M., and D. P. DeMaster. 1985. Use of pup counts in indexing population changes in pinnipeds. Can. J. of Fish. Aquat. Sci. 42: 873-879.

Bering Sea Coalition. 1999. "Wisdom Keepers of the North: Vision, Healing and Stewardship for the New Millennia." Conference Final Report,, Bering Sea Coalition, P.O. Box 773556, Chugiak, Alaska 99577. p..

Bond, N. A., Overland, J. E., and Turet, P. 1994. "Spatial and temporal characteristics of the wind forcing of the Bering Sea." *Journal of Climate*, 7, pp. 1119-1130.

Bonnell, M. L., Pierson, M. O., and Farrens, G. D. 1983. "Pinnipeds and sea otters of central and northern California, 1980-1983: status, abundance and distribution." Final report for contract AA551-CT9-33 to U.S. Department of the Interior, Minerals Management Service Center for Marine Studies, University of California,,, Santa Cruz.

Boveng, P., D. P. DeMaster, and B. S. Stewart. 1988. Dynamic response analysis. III. A consistency filter and application to four northern elephant seal colonies. Mar. Mammal Sci. 4: 210-222.

Braham, H. W., Burns, J. J., Fedoseev, G. A., and Krogman, B. D. 1984. "Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walruses in the Bering Sea, April 1976." Soviet-American cooperative research on marine mammals, F. H. Fay and G. A. Fedoseev, eds., pp. 25-47.

Briggs, L., and C. W. Fowler. 1984. Table and figures of the basic population data for northern fur seals of the Pribilof Islands. *In* Background papers submitted by the United States to the 27th annual meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, March 29-April 9, 1984, Moscow, U.S.S.R. (available on request - National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA, 98115).

Brodeur, R. D., Mills, C. E., Overland, J. E., Walters, G. E., and Schumacher, J. D. 1999. "Evidence for a substantial increase in gelatinous zooplankton in the Bering Sea, with possible links to climate change." *Fisheries Oceanography*, 8(4), pp. 292-306.

Brodeur, R. D., and Wilson, M. T. 1996. “A review of the distribution, ecology, and population dynamics of age-0 walleye pollock in the Gulf of Alaska.” *Fisheries Oceanography*, 5(Supplement 1), pp. 148-166.

Brooks, J. W. 1954. “A contribution to the life history and ecology of the Pacific walrus.” Special Report, *1*, Alaska Coop. Wildl. Res. Unit, University of Alaska Fairbanks, Fairbanks, AK 99775. p. 103.

Burns, J. J. 1965. “The walrus in Alaska: its ecology and management.” Fed. Aid Wildlife Restoration Project Report, *5*, Alaska Department of Fish and Game. p. 48.

Burns, J. J. 1970. “Remarks on the distribution and natural history of pagophilic pinnipeds in the Bering and Chukchi Seas.” *Journal of Mammalogy*, 51, pp. 445-454.

Burns, J. J. 1973. “Marine Mammal report.” *W-17-3, W-17-4, W-17-5*, Pittman-Robertson.

Burns, J. J. 1981a. “Bearded seal, *Erignathus barbatus* Erxleben, 1777.” Handbook of Marine Mammals, S. H. Ridgway and R. J. Harrison, eds., Academic Press, New York, pp. 145-170.

Burns, J. J. 1981b. “Ribbon seal, *Phoca fasciata*.” Handbook of Marine Mammals, S. H. Ridgway and R. J. Harrison, eds., Academic Press, New York, pp. 89-109.

Byrd, G. V., and Dragoo, D. E. 1997. “Breeding success and population trends of selected seabirds in Alaska in 1996.” U.S. Fish and Wildlife Service Report, *AMNWR 97/11*, U.S. Department of the Interior, U.S. Fish and Wildlife Service, 1211 E. Tudor Road, Anchorage, AK 99503. p. 44.

Byrd, G. V., Dragoo, D. E., and Irons, D. B. 1998. “Breeding status and population trends of seabirds in Alaska in 1997.” U.S. Fish and Wildlife Service Report, *AMNWR 98/02*, U.S. Department of the Interior, U.S. Fish and Wildlife Service, 1211 E. Tudor Road, Anchorage, AK 99503. p. 59.

Byrd, G. V., Dragoo, D. E., and Irons, D. B. 1999. “Breeding status and population trends of seabirds in Alaska in 1998.” U.S. Fish and Wildlife Service Report, *AMNWR 99/02*, U.S. Department of the Interior, U.S. Fish and Wildlife Service, 1211 E. Tudor Road, Anchorage, AK 99503. p. 68.

Calkins, D. G., and Goodwin, E. 1988. “Investigation of the declining sea lion population in the Gulf of Alaska.”, State of Alaska, Department of Fish and Game, Anchorage Regional Office, 333 Raspberry Road, Anchorage, AK 99518. p. 76.

Calkins, D. G., and Pitcher, K. W. 1982. “Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska.” OCSEAP Final Report, *19 (1983)*, U.S. Department of Commerce, NOAA. pp. 445-546.

CEQ. 1997. Considering cumulative effects under the National Environmental Policy Act, Council on Environmental Quality, Washington, D.C.

Christensen, V. 1990. “The ECOPATH II software, or how we can gain from working together.” *NAGA*, 13, pp. 9-10.

Christensen, V. 1992. "A model of trophic interactions in the North Sea in 1981, the year of the stomach." Rep. C.M., *1992/L*, International Council for the Exploration of the Sea, Copenhagen, DK. p. 25.

Christensen, V. 1994. "Energy-based ascendancy." *Ecological Modelling*, 72, pp. 129-144.

Credle, V. R., DeMaster, D. P., Merklein, M. M., Hanson, M. B., Karp, W. A., and Fitzgerald, S. M. e. 1994. "NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993." NOAA Technical Memorandum, *NMFS-OPR-94-1*, U.S. Department of Commerce, NOAA. p. 96.

Decker, M. B., Hunt Jr, G. L., and Byrd Jr., G. V. 1995. "The relationships among sea-surface temperature, the abundance of juvenile walleye pollock (*Theragra chalcogramma*), and the reproductive performance and diets of seabirds at the Pribilof Islands, southeastern Bering Sea." Climate change and northern fish populations, R. J. Beamish, ed., Canadian Special Publication of Fisheries and Aquatic Sciences, pp. 425-437.

DeLong, R. L. 1982. Population biology of northern fur seals at San Miguel Island, California. Ph.D. dissertation, University of California, Berkeley, CA. 185 pp.

DeLong, R. L., and G. A. Antonelis. 1991. Impact of the 1982-1983 EI Nino on northern fur seal population at San Miguel Island, California, pp. 75-83 in F. Trillmich and K. Dno (Eds.), Pinnipeds and the 1982-83 EI Nino in the North Pacific. University of California Press, Berkeley.

DeMaster, D. P. 1998. Minutes from sixth meeting of the Alaska Scientific Review Group, 21-23 October 1997, Seattle, Washington. 40 pp. (available upon request - D. P. DeMaster, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

Dorn, M., Hollowed, A., Brown, E., Megrey, B., Wilson, C., and Blackburn, J. 1999. "Walleye pollock." Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252, p. 67.

Dwyer, D. A. 1984. "Feeding habits and daily ration of walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea," Masters Thesis, University of Washington, Seattle, WA.

Eberhardt, L. L., and D. B. Siniff. 1977. Population dynamics and marine mammal management policies. J. Fish. Res. Board Can. 34: 183-190.

Fadley, B. S., Zeligs, J. A., and Costa, D. P. 1994. "Assimilation efficiencies and maintenance requirements of California sea lions (*Zalophus californianus*) fed walleye pollock (*Theragra chalcogramma*) and herring (*Clupea harengus*)." Final Report to the National Marine Mammal Laboratory. p. 29.

Favorite, F., Dodimead, A. J., and Nasu, K. 1976. "Oceanography of the Subarctic Pacific region, 1960-71." International North Pacific Fisheries Commission Bulletin, *33*, International North Pacific Fisheries Commission, 6640 Northwest Marine Drive, Vancouver, BC, Canada V6T 1X2. p. 187.

Fay, F. H. 1955. "The Pacific Walrus (*Odobenus rosmarus divergens*): spatial ecology, life history, and population," Ph.D. Thesis, University of British Columbia, Vancouver.

Fay, F. H. 1982. "Ecology and biology of the Pacific walrus, (*Odobenus rosmarus divergens*)." *Illiger. N. Am. Fauna*, 74, p. 279.

Fay, F. H., Kelly, B. P., Gehnrich, P. H., Sease, J. L., and Hoover, A. A. 1984. "Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus." OCSEAP Final Report, *37*, U.S. Department of Commerce, NOAA. pp. 231-376.

Ferrero, R. C., DeMaster, D. P., Hill, P. S., and Muto, M. 2000. "Alaska marine mammal stock assessments, 2000." NOAA Technical Memorandum,, U.S. Department of Commerce, NOAA. p. 176.

Fiscus, C. H., Braham, H. W., Mercer, R. W., Everitt, R. D., Krogman, B. D., McGuire, P. D., Peterson, C. E., Sonntag, R. M., and Withrow, D. E. 1976. "Seasonal distribution and relative abundance of marine mammals in the Gulf of Alaska." Quarterly Report, *1*, U.S. Department of Commerce, NOAA, OCSEAP Environmental Assessment Alaskan Continental Shelf. pp. 19-264.

Fowler, C. W. 1987. Marine debris and northern fur seals: A case study. Mar. Poll. Bull. 18:326-335.

Fowler, C. W., and T. J. Ragen. 1990. Entanglement studies, St. Paul Island, 1989; Juvenile male roundups. U.S. Dep. Commer., NWAFC Processed Rep. 90-06, 39 pp. (Available upon request - Alaska Fish. Sci. Cent., NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115).

Fowler, C. W., J. D. Baker, R. Ream, B. W. Robson, and M. Kiyota. 1994. Entanglement studies on juvenile male northern fur seals, St. Paul Island, 1992. Pp. 100-136, *In* Sinclair, E. H. (editor), Fur seal investigations, 1992, U.S. Dep. Commer., NOAA Tech. Memo.

Fowler, C. W. 1981. Density dependence as related to life history strategy. Ecol. 62: 602-610.

Fowler, C. W .1986. Report of the workshop on the status of northern fur seals on the Pribilof Islands, November 14-16, 1983, Processed Report 86-01. U.S. Department of Commerce, Alaska Fisheries Science Center, Seattle, Washington. 50 pp.

Fowler, C. W. 326-335. 1987a. Marine debris and northern fur seals: A case study, Mar. Poll. Bull. 18:

Fowler, C. W. 1987b. A review of density dependence in populations of large mammals. pp. 401-441 in H. H. Genoways (Ed.), Current Mammalogy, Vol. 1, p. 401-441. Plenum Publication Corp., New York, NY.

Fowler, C. W. 1988. Population dynamics as related to rate of increase per generation. Evol. Ecol: 2: 197-204.

Fowler, C. W., and T. J. Ragen. 1990. Entanglement studies, St. Paul Island, 1989 juvenile male northern fur seals. U.S. Department of Commerce, *NOAA/NMFS/NWAFC* Proc. Report 90-06, Seattle, Washington. 39 pp.

Francis, R. C., and Hare, S. R. 1994. "Decadal-scale regime shifts in the large marine ecosystems of the North-east Pacific: a case for historical science." *Fisheries Oceanography*, 3, pp. 279-291.

Francis, R. C., Hare, S. R., Hollowed, A. B., and Wooster, W. S. 1998. "Effects of interdecadal climate variability on the oceanic ecosystems of the northeast Pacific Ocean." *Fisheries Oceanography*, 7(1), pp. 1-21.

Fritz, L. W. 1996. "Juvenile walleye pollock, *Theragra chalcogramma*, bycatch in commercial groundfish fisheries in Alaskan waters." Ecology of Juvenile Walleye Pollock, *Theragra chalcogramma*, R. D. Brodeur, P. A. Livingston, T. R. Loughlin, and A. B. Hollowed, eds., U.S. Department of Commerce, NOAA, NOAA Technical Report NMFS 126.

Fritz, L. W., Ferrero, R. C., and Berg, R. J. 1995. "The threatened status of Steller sea lions, *Eumetopias jubatus*, under the Endangered Species Act: Effects on Alaska Groundfish Management." *Marine Fisheries Review*, 57(2), pp. 14-27.

Frost, K. J., Lowry, L. F., Gilbert, J. R., and Burns, J. J. 1988. "Ringed seal monitoring: relationships of distribution and abundance to habitat attributes and industrial activities." Final Rep. Contract, *84-ABC-00210*, U.S. Department of the Interior, Minerals Management Service, Anchorage, AK. p. 101.

Furness, R.W. 1982. Competition between fisheries and seabird communities. Pages 225-307. In: J.H.S. Blaxter, F.S. Russell, and M. Yonge (eds.) Advances in Marine Biology, Volume 20. Academic Press, Inc; New York, New York.

Furness, R.W. 1984. Modelling relationships among fisheries, seabirds, and marine mammals. Pages 117-126. In: D.N. Nettleship, G.A. Sanger, and P.F. Springer (eds.) Marine birds: their feeding ecology and commercial fisheries relationships. Canadian Wildlife Service; Ottawa, Canada.

Gentry, R. L. 1970. "Social behavior of the Steller sea lion," Ph.D., University of California, Santa Cruz.

Gentry, R. L., and Kooyman, G. L. 1986. Fur Seals. Maternal Strategies on Land and At Sea, Princeton University Press, Princeton, NJ,

Gentry, R. L. 1991. EI Nino effects on adult northern fur seals at the Pribiloflslands. pp. 84-93 in Trillmich, F. and K. Ono (Eds.), Pinnipeds and the 1982-83 EI Nino in the North Pacific. University of California Press, Berkeley, California. NMFS-AFSC-45.

Gerrodette, T., D. Goodman, and J. Barlow. 1985. Confidence limits for population projections when vital rates vary randomly. Fish. Bull. 83:207-217.

Gisiner, R. C. 1985. "Male territorial and reproductive behavior in the Steller sea lion, (*Eumetopias jubatus*)," Ph. D., University of California, Santa Cruz.

Goebel, M. E., Bengtson, J. L., DeLong, R. L., Gentry, R. L., and Loughlin, T. R. 1991. "Diving patterns and foraging locations of female northern fur seals." *Fishery Bulletin*, 89, pp. 171-179.

Goodman, D. 1988. Dynamic response analysis. I. Qualitative estimation of stock status relative to maximum net productivity level from observed dynamics. Mar. Mammal Sci. 4: 183-195.

Hare, S. R., and Mantua, N. J. 2000. “Empirical evidence for Northeast Pacific regime shifts in 1977 and 1989.” *Progress in Oceanography*, 46, pp. 6-50.

Harry, G. Y., and J. R. Hartley. 1981. Northern fur seals in the Bering Sea, pp. 847-867jn Hood, D. W. and J. A. Calder (Eds.), The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. II. Univ. of Washington Press, Seattle, Washington.

Hatch, S. A. 1987. Did the 1982-1983 EI Nino-southern oscillation affect seabirds in Alaska? The Wilson Bulletin 99: 468-474.

Hattori, A. 1979. “Preliminary report of the Haukho Maru cruise KH-78-3.”, Ocean Research Institute, University of Tokyo, Japan.

Hattori, A., and Goering, J. J. 1986. “Nutrient distributions and dynamics in the eastern Bering Sea.” The Eastern Bering Sea Shelf: Oceanography and Resources, D. W. Hood and J. A. Calder, eds., University of Washington Press, Seattle, WA, pp. 975-992.

Hill, P. S., and DeMaster, D. P. 1999. “Alaska Marine Mammal Stock Assessments, 1999.” NOAA Technical Memorandum, *NMFS-AFSC-110*, U.S. Department of Commerce, NMFS, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115. p. 166.

Hollowed, A. B., Brown, E., Ianelli, J., Livingston, P., Megrey, B., and Wilson, C. 1997. “Walleye pollock.”, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252. pp. 362-396.

Hollowed, A. B., Hare, S. R., and Wooster, W. S. 1998. “Pacific-Basin climate variability and patterns of northeast Pacific marine fish production. *In* Biotic Impacts of Extratropical Climate Variability in the Pacific.” *Proceedings 'Aha Huliko'a Hawaiian Winter Workshop*, University of Hawaii at Manoa, pp. 1-21.

Hollowed, A. B., and Wooster, W. S. 1995. “Decadal-scale variations in the eastern Subarctic Pacific: II. Response of Northeast Pacific fish stocks. In Climate Change and Northern Fish Populations.” *Canadian Special Publication of Fisheries and Aquatic Sciences*, 121, pp. 373-385.

Honkalehto, T. 1989. “A length-cohort analysis of walleye pollock based on empiracal estimation of cannibalism and predation by marine mammals. Proceedings Intl. Symp. Biol. Management Walleye Pollock, November 1988.” Alaska Sea Grant Report, *89-1*, University of Alaska Fairbanks, Fairbanks, AK 99775. pp. 651-665.

Hood, D.W. and J.A. Calder (eds). 1981. The eastern Bering Sea shelf: oceanography and resources, Vol. 1 and 2. Office of Marine Pollution Assessment, NOAA and BLM. Univ of Washington Press, Seattle, WA. 1,339 pp

Hood, D.W. and S. T. Zimmerman (Eds.). 1987. The Gulf of Alaska. Physical environment and its biological resources, U.S. Dep Commerce, NOAA, NOS, Office of Oceanogr and Marine Assess., Ocean Assess. Division, Alaska Office, available NITS, Springfield, VA as PB87-103230. 655 pp.

ICES International Symposium, Recruitment Dynamics of exploited marine populations: physical-biological interactions. Baltimore, MD.

Hunt Jr, G. L., Gould, P. J., Forsell, D. J., and Peterson Jr., H. 1981. "Pelagic distribution of marine birds in the eastern Bering Sea." The eastern Bering Sea shelf: oceanography and resources, D. W. Hood and J. A. Calder, eds., University of Washington Press, pp. 689-718.

Hunt Jr., G. L., Decker, M. B., and Kitaysky, A. 1995. "Fluctuations in the Bering Sea ecosystem as reflected in the reproductive ecology and diets of kittiwakes on the Pribilof Islands, 1975 to 1990." Aquatic Predators and their Prey, S. P. R. Greenstreet and M. L. Tasker, eds., Blackwell Scientific Publications, Oxford.

Ianelli, J., Fritz, L., Honkalehto, T., Williamson, N., and Walters, G. 1999. "Walleye pollock." Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea and Aleutian Islands region, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252, p. 88.

Ingraham Jr., W. J., Ebbesmeyer, C. C., and Hinrichsen, R. A. 1998. "Imminent Climate and Circulation Shift in Northeast Pacific Ocean Could Have Major Impact on Marine Resources." *EOS, Transactions, American Geophysical Union*.

Johnson, M. L., Fiscus, C. H., Ostenson, B. T., and Barbour, M. L. 1966. "Marine Mammals." Environment of the Cape Thomson Region, Alaska, N. J. Wilimovsky and J. N. Wolfe, eds., U.S. Atomic Energy Commn., Oak Ridge, TN, pp. 877-924.

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal, *Callorhinus ursinus*, in the eastern North Pacific Ocean and eastern Bering Sea. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-779, 49 pp.

Kajimura, H., R. H. Lander, M. A. Perez, A. E. York, and M. A. Bigg. 1979. Preliminary analysis of pelagic fur seal data collected by the United States and Canada during 1958-1974. Available U. S. Department of Commerce, NOAA/NMFS/N ational Marine Mammal Laboratory Rept., Seattle, Washington. (unpublished).

Kajimura, H., and Fowler, C. W. 1984. "Apex predators in the walleye pollock ecosystem in the eastern Bering Sea and Aleutian Islands regions." NOAA Technical Memorandum, *NMFS F/NWC-62*, U.S. Department of Commerce, NOAA. pp. 193-234.

Kajimura, H., and Loughlin, T. R. 1988. "Marine mammals in the oceanic food web of the eastern subarctic Pacific." *Bulletin of the Ocean Research Institute, University of Tokyo*, 26 (part II), pp. 187-223.

Kajimura, H., R. H. Lander, M. A. Perez, A. E. York, and M. A. Bigg. 1979. Preliminary analysis of pelagic fur seal data collected by the United States and Canada during 1958-1974. Available U. S. Department of Commerce, NOAA/NMFS/N ational Marine Mammal Laboratory Rept., Seattle, Washington. (unpublished

Kawasaki, T. 1991. "Long-term variability in the pelagic fish populations." Long-term variability of pelagic fish populations and their environment, T. Kawasaki, S. Tanaka, Y. Toba, and A. Taniguchi, eds., Pergamon Press, New York, pp. 47-60.

Kelly, B. P. 1988. "Ringed seal, *Phoca hispida*." Selected marine mammals of Alaska species accounts with research and management recommendations, J. W. Lentfer, ed., Marine Mammal Commission, Washington, DC, pp. 57-75.

Kenyon, K. W., and Rice, D. W. 1961. "Abundance and distribution of the Steller sea lion." *Journal of Mammalogy*, 42, pp. 223-234.

Kinder, T. H., and Schumacher, J. D. 1981. "Hydrographic Structure Over the Continental Shelf of the Southeastern Bering Sea." The Eastern Bering Sea Shelf: Oceanography and Resources, D. W. Hood and J. A. Calder, eds., University of Washington Press, Seattle, WA, Seattle, WA, pp. 31-52.

King, J. E. 1983. *Seals of the world*, British Museum of Natural History, London. 240 pp.

Knechtel, C. D., and Bledsoe, L. J. 1981. "A numerical simulation model of the population dynamics of walleye pollock, *Theragra chalcogramma* (Pallas 1811), in a simplified ecosystem. Part I, Model Description." NOAA Technical Memorandum, *NMFS F/NWC-19*, U.S. Department of Commerce, NOAA. p. 212.

Knechtel, C. D., and Bledsoe, L. J. 1983. "A numerical simulation model of the population dynamics of walleye pollock, *Theragra chalcogramma* (Pallas 1811), in a simplified ecosystem: Part II, Model calibration, validation, and exercise." NOAA Technical Memorandum, *NMFS F/NWC-50*, U.S. Department of Commerce, NOAA. p. 264.

Kurle. K.M. and G.A.J. Worthy. 2000. Stable isotope assessment of temporal and geographic differences in feeding ecology of northern fur seals (Callorhinus ursinus) and their prey. Oecologia 126: 254-265.

Laevastu, T., and Favorite, F. 1988. *Fishing and stock fluctuations*, Fishing News Books Ltd, Farnham, Surrey, England. 239 pp.

Laevastu, T., and Larkins, H. A. 1981. *Marine fisheries ecosystem, its quantitative evaluation and management*, Fishing News Books Ltd., Farnham, Surrey, England. 159 pp.

Laist, D. 1987. Overview of the biological effects of lost and idscarded plastic deris in the marine environment. Mar. Poll. Bull. 18: 319-326.

Laist, D. 1997. Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. Marine Debris, sources, impacts and solutions. J. Coe and D.B. Rogers, Eds., Springer-Verlag, New York, NY, pp. 99-140.

Lander, R. H. 1981. A life table and biomass estimate for Alaskan fur seals. Fish. Res. (Amst.) 1:55-70.

Lander, R. H., and H. Kajimura. 1982. Status of northern fur seals. FAO Fisheries Series 5:319-345.

Lang, G. M., and Livingston, P. A. 1996. "Food habits of key groundfish species in the eastern Bering Sea slope region." NOAA Technical Memorandum, *NMFS-AFSC-297*, U.S. Department of Commerce, NOAA. p. 110.

Larntz, K., and R. Garrott. 1993. Analysis of 1991 bycatch of selected mammal species in the North Pacific neon squid driftnet fishery. Final contract report prepared for the NMFS, 68 pp. + appendices.

Livingston, P. A. 1991a. "Total groundfish consumption of commercially important prey." NOAA Technical Memorandum, *NMFS F/NWC-207*, U.S. Department of Commerce, NOAA. p. 240.

Livingston, P. A. 1991b. "Groundfish food habits and predation on commercially important prey species in the Eastern Bering Sea from 1984-1986." NOAA Technical Memorandum, *NMFS F/NWC-207*, U.S. Department of Commerce, NOAA. p. 240.

Livingston, P. A. 1993. "Importance of predation by groundfish, marine mammals and birds on walleye pollock and Pacific herring in the eastern Bering Sea." *Marine Ecology Progress Series*, 102, pp. 205-215.

Livingston, P. A. 1994. "Overview of multispecies interactions involving walleye pollock in the eastern Bering Sea and Gulf of Alaska." Draft manuscript,, DOC, NOAA, NMFS, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115.

Livingston, P.A. 2001. Climate forcing effects on trophically-linked groundfish populations. AFSC, Report, May-June 2001, NMFS, Seattle, WA.

Livingston, P. A., and DeReynier, Y. 1996. "Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1990 to 1992." AFSC Processed Report, *96-04*, DOC, NOAA, NMFS, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115. p. 214.

Livingston, P. A., Low, L.-L., and Marasco, R. J. 1999. "Eastern Bering Sea Ecosystem Trends." Large Marine Ecosystems of the Pacific Rim: Assessment, Sustainability, and Management, K. Sherman and Q. Tang, eds., Blackwell Science, Inc., Malden, MA, pp. 140-162.

Livingston, P. A., Ward, A., Lang, G. M., and Yang, M. S. 1993. "Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1987 to 1989." NOAA Technical Memorandum, *NMFS-AFSC-11*, U.S. Department of Commerce, NOAA. p. 192.

Lloyd, D. S., McRoy, C. P., and Day, R. H. 1981. "Discovery of northern fur seals (*Callorhinus ursinus*) breeding on Bogoslof Island, southeastern Bering Sea." *Arctic*, 34, pp. 318-320.

Loughlin, T. R., Perlov, A. S., and Vladimirov, V. V. 1992. "Range-wide survey and estimation of total number of Steller sea lions in 1989." *Marine Mammal Science*, 8, pp. 220-239.

Loughlin, T. R., Rugh, D. J., and Fiscus, C. H. 1984. "Northern sea lion distribution and abundance: 1956 - 80." *Journal of Wildlife Management*, 48(3), pp. 729-740.

Loughlin, T. R., and Ohtani, K. 1999. Dynamics of the Bering Sea, University of Alaska Sea Grant, Fairbanks, 838 pp.

Loughlin, T. R., and R. L. Merrick. 1989. Comparison of commercial harvest of walleye pollock and northern sea lion abundance in the Bering Sea and Gulf of Alaska, p. 679-700. In Proceedings of the international symposium on the biology and management of walleye pollock, November 14-16, 1988, University of Alaska, Fairbanks, Sea Grant Report AK-SG-89-1.

Lowry, L. F., Frost, K. J., and Loughlin, T. R. 1989. "Importance of walleye pollock in the diets of marine mammals in the Gulf of Alaska and Bering Sea, and implications for fishery management." Alaska Sea Grant Report, *AK-SG-89-01*, Anchorage, AK. pp. 701-726.

Lowry, L. F. 1982. "Documentation and assessment of marine mammal-fishery interactions in the Bering Sea." *Trans. 47th North American Wildlife and Natural Resource Conference*, Portland, Oregon, pp. 300-311.

Lowry, L. F., and Frost, K. H. 1981. "Feeding and trophic relationships of phocid seals and walruses in the eastern Bering Sea." The eastern Bering Sea shelf: oceanography and resources, D. W. Hood and J. A. Calder, eds., U.S. Department of Commerce, NOAA, Office of Marine Pollution Assessment, Juneau, AK, pp. 813-824.

Lowry, L. F., and Frost, K. J. 1985. "Biological interactions between marine mammals and commercial fisheries in the Bering Sea." Marine mammals and fisheries, J. R. Beddington, R. J. H. Beverton, and D. M. Lavigne, eds., George Allen & Unwin, London, pp. 42-61.

Lowry, L. F., Frost, K. J., Calkins, D. G., Swartzman, G. L., and Hills, S. 1982. "Feeding habits, food requirements, and status of Bering Sea marine mammals." *Document Nos. 19 and 19A*, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252. p. 574.

Lowry, L. F., Frost, K. J., Davis, R., DeMaster, D. P., and Suydam, R. S. 1998. "Movements and behavior of satellite-tagged spotted seals (*Phoca largha*) in the Bering and Chukchi Seas." *Polar Biology*, 19, pp. 221-230.

Lucas, F. A. 1899. "The food of the northern fur seals." The fur seals and fur-seal islands of the North Pacific Ocean, Part 3, D. S. Jordan, ed., U.S. Treasury Department Document 2017, pp. 59-68.

Mantua, N. J., Hare, S. R., Zhang, Y., Wallace, J. M., and Francis, R. C. 1997. "A pacific interdecadal climate oscillation with impacts on salmon production." *Bulletin of the American Meteorological Society*, 78(6).

McLaren, I. A. 1985. "The biology of the ringed seal (*Phoca hispida* Schreber) in the eastern Canadian Arctic." *Fisheries Research Board of Canada Bulletin*, 118, p. 97.

Megrey, B. A. and Wespestad, V. G. 1990. "Alaskan groundfish resources: Ten years of management under the Magnuson-Fishery Conservation and Management Act." North American Journal of Fisheries Management 10 (2) :125-143.

Merrick, R. L., and Calkins, D. G. 1995. "Importance of juvenile walleye pollock in the diet of Gulf of Alaska sea lions.",, Unpublished manuscript. National Marine Fisheries Service, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, p. 35.

Merrick, R. L., and Calkins, D. G. 1996. "Importance of juvenile walleye pollock, *Theragra chalcogramma*, in the diet of Gulf of Alaska Steller sea lions, *Eumetopia jubatus*." NOAA Technical Memorandum, *126*, U.S. Department of Commerce, NOAA. pp. 153-166.

Merrick, R. L., and Loughlin, T. R. 1997. "Foraging behavior of adult female and young-of-the-year Steller sea lions (*Eumetopias jubatus*) in Alaskan waters." *Canadian Journal of Zoology*, 75(5), pp. 776-786.

Merrick, R. L., Loughlin, T. R., and Calkins, D. G. 1987. "Decline in abundance of the northern sea lion, (*Eumetopias jubatus*) in Alaska, 1956-86." *Fishery Bulletin*, 85(2), pp. 351-365.

Miller, M., D. Lipton, and P. Hooker. 1994. Profile of Change: a review of offshore factory trawler operations in the Bering Sea and Aleutian Islands Pollock Fishery.

Minobe, S. 1997. "A 50-70 year climatic oscillation over the North Pacific and North America." *Geophysical Research Letters*, 24(6), pp. 683-686.

Minobe, S. 1999. "Resonance in bidecadal and pentadecadal climate oscillations over the North Pacific: Role in climatic regime shifts." *Geophysical Research Letters*, 26, pp. 855-858.

Moore, S. E., and Reeves, R. R. 1993. "Distribution and movement." The bowhead whale, J. J. Burns, J. J. Montague, and C. J. Cowles, eds., Soc. Mar. Mammalogy, pp.

National Research Council. 1996. *The Bering Sea Ecosystem*, National Academy Press, Washington, DC. 307 pp.

National Research Council. 1999. *Sustaining Marine Fisheries*, National Academy Press, Washington, DC. 165 pp.

Niebauer, H. J. 1988. "Effects of El-Nino-Southern Oscillation and North Pacific weather patterns on interannual variability in the Bering Sea." *Journal of Geophysical Research*, 93, pp. 5051-5068.

Niebauer, H. J., Alexander, V. A., and Hendricks, S. 1990. "Physical and biological oceanographic interaction in the Spring Bloom at the Bering Sea marginal ice edge zone." *Journal of Geophysical Research*, 95, pp. 22,229-22,242.

NMFS. 1993. "Final conservation plan for the northern fur seal (*Callorhinus ursinus*).", Prepared by the National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory, Seattle, Washington and the NMFS/Office of Protected Resources, Silver Spring, MD. p. 80.

NMFS. 2001. Steller Sea Lion Protection Measures, Final Supplemental Environmental Impact Statement, NOAA, NMFS, Alaska Region. November 2001.

NMFS. 2003. Addendum to the Biological Opinion and Incidental Take Statement of October 2001 as order by the U.S. District Court for the Western District of Washington (Greenpeace v. NMFS, No. C98-492Z.

NPFMC. 1993. "Environmental Assessment and Regulatory Impact of Amendment 37 to the Fishery Management Plans for the Groundfish Fishery of the Bering Sea and Aleutian Islands.", North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

NPFMC. 1998a. "Draft environmental impact assessment/regulatory impact review: Essential Fish Habitat.", North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252. p. 358.

NPFMC. 1998b. "Essential fish habitat assessment report for the groundfish resources of the Bering Sea and Aleutian Islands region.", North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252. p. 125.

NPFMC. 1999. "Draft Environmental Assessment /Regulatory Impact Review/Initial Regulatory Flexibility Analysis for Amendments 63/63 to the Fishery Management Plans for the Groundfish Fisheries of the Bering Sea/Aleutian Islands and Gulf of Alaska to revise management of Sharks and Skates.", North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

NPFMC. 2000a. "Fishery Management Plan for the Groundfish Fishery in the BSAI Area." Updated through Amendment 66, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

NPFMC. 2000b. "Fishery Management Plan for the Groundfish of the GOA." Updated through Amendment 65 In Prep. North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

NPFMC. 2000c. "Draft Environmental Assessment /Regulatory Impact Review for Amendments 65/65/12/7/7: Habitat Areas of Particular Concern.", North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

NPFMC. 2000d. "Draft Environmental Assessment/Regulatory Impact Review - Harvest Controls for HAPC Biota.", North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501-2252.

Nunnallee, E. P., and N. J. Williamson. 1989. Results of acoustic-midwater trawl surveys of walleye pollock in Shelikof Strait, Alaska, 1988, p. 225-242. In T. K. Wilderbuer (editor), Condition of groundfish resources of the Gulf of Alaska in 1988. U.S. Department of Commerce, NOAA Tech. Memo. NMFS *F/NWC-165.*

Odum, E. P. 1971. Fundamentals of ecology. Third Edition. Saunders College Publishing; Philadelphia, Pennsylvania.

Ognev, S. I. 1935. *Mammals of the U.S.S.R. and adjacent countries*, I. P. S. Transl., translator,, Moscow.

Parker, K. S., Royer, T. S., and Deriso, R. B. 1995. "High-latitude climate forcing and tidal mixing by the 18.6-year lunar nodal cycle and low-frequency recruitment trends in Pacific halibut (*Hippoglossus stenolepis*) IN Climate Change and Northern Fish Populations." *Canadian Special Publication of Fisheries and Aquatic Sciences*, 121, pp. 449-459.

Pauly, D., and Christensen, V. 1995. "The primary production required to sustain global fisheries." *Nature*, 374, pp. 255-257.

Perez, M. A. 1990. "Review of marine mammal population and prey information for Bering Sea ecosystem studies." NOAA Technical Memorandum, *NMFS F/NWC-186*, U.S. Department of Commerce, NOAA. p. 81.

Perez, M. A., and Bigg, M. A. 1986. "Diet of northern fur seals, *Callorhinus ursinus*, off western North America." *Fishery Bulletin*, 84(4), pp. 959-973.

Perez, M. A., and McAlister, B. 1993. "Estimates of food consumption by marine mammals in the eastern Bering Sea." NOAA Technical Memorandum, *NMFS-AFSC-14*, U.S. Department of Commerce, NOAA. p. 36.

Perez, M. A., and Loughlin, T. R. 1991. "Incidental catch of marine mammals by foreign and joint venture trawl vessels in the U.S. EEZ of the North Pacific, 1973-88." NOAA Technical Report, *NMFS 104*, DOC, NOAA, NMFS. p. 57.

Piatt, J. F., and Anderson, P. J. 1996. "Response of Common Murres to the *Exxon Valdez* oil spill and long-term changes in the Gulf of Alaska ecosystem." *American Fisheries Society Symposium*, 18, pp. 720-737.

Pimm, S. 1982. *Food webs*, Chapman and Hall, London, UK.

Pitcher, K. W. 1980a. "Stomach contents and feces as indicators of harbor seal, *Phoca vitulina*, foods in the Gulf of Alaska." *Fishery Bulletin*, 78(3), pp. 797-798.

Pitcher, K. W. 1980b. "Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska." *Fishery Bulletin*, 78(2), pp. 544-549.

Pitcher, K. W. 1981. "Prey of Steller sea lion, *Eumetopias jubatus*, in the Gulf of Alaska." *Fishery Bulletin*, 79(3), pp. 467-472.

Pitcher, K. W. 1990. "Major decline in number of harbor seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska." *Marine Mammal Science*, 6, pp. 121-134.

Pitcher, K. W., and Calkins, D. G. 1981. "Reproductive biology of Steller sea lions in the Gulf of Alaska." *Journal of Mammalogy*, 62, pp. 599-605.

Popov, L. A. 1976. "Status of main ice forms of seals inhabiting waters of the U.S.S. R. and adjacent to the country marine areas." *ACMRR/MM/SC/51*, Food and Agriculture Organization of the United Nations. p. 17.

Pruter, A. T. 1976. "Soviet fisheries for bottomfish and herring off the Pacific and Bering Sea Coasts of the United States." paper 1225,, Marine Fisheries Review. pp. 1-15.

Quinn II, T. J., and Niebauer, H. J. 1995. "Relation of eastern Bering Sea walleye pollock (*Theragra chalcogramma*) recruitment to environmental and oceanographic variables. IN Climate Change and Northern Fish Populations." *Canadian Special Publication of Fisheries and Aquatic Sciences*, 121, pp. 497-507.

Ream, R. R., J. D. Baker, R. T. Towell. 1999. Bogoslof Island Studies, 1997. Pp. 81-92, *In* E. H. Sinclair and B. W. Robson (ed.), Fur seal investigations, 1997. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-106, 109p.

Reed, R. K. 1984. "Flow of the Alaskan Stream and its variations." *Deep-Sea Research*, 31, pp. 369-386.

Reed, R. K. 1995. "Water properties over the Bering Sea Shelf: climatology and variations." NOAA Technical Report, *ERL 452-pmel 42*, U.S. Department of Commerce, NOAA, Environmental Research Laboratories. p. 15.

Robson, B.W. 2001. The relationship between foraging locations in breeding sites of lactating northern fur seals, Callorhinus ursinus, in the eastern Bering Sea. Ms. Thesis, University of Washington, Seattle WA.

Ronholt, L. L., Wakabayaski, K., Wilderbuer, T. K., Yamaguchi, H., and Okada, K. 1985. "Results of the cooperative U.S.-Japan groundfish assessment survey in Aleutian Islands water, June-November 1980." Unpublished manuscript,, U.S. Department of Commerce, NOAA, Northwest and Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115. p. 303.

Roppel, A.Y. 1984. Management of northern fur selas on the Pribilof Islands, Alaska, 1786-1981. U.S. Dept. of Interior, NOAA Tech. Report NMFS-4. 26 pp.

Roppel, A.Y. and S.P. Davey. 1965. Evolution of fur seal management on the Pribilof Islands. J. Wildlife Mgmt. 29: 448-463

Rosen, D. A. S., and Trites, A. W. 1997. "Heat increment of feeding in Steller sea lions, *Eumetopias jubatus*." *Comparative Biochemistry Physiology*, 118A(3), pp. 877-881.

Rosen, D. A. S., and Trites, A. W. 1998. "The metabolic effects of a low-energy prey on Steller sea lions, *Eumetopias jubatus*.", University of British Columbia, 2204 Main Mall, Vancouver, BC Canada V6T 1Z4. p. 32.

Rosenkranz, G. E., Tyler, A. V., Kruse, G. H., and Niebauer, H. J. 1998. "Relationship between wind and year class strength of Tanner crabs in the southeastern Bering Sea." *Alaska Fishery Research Bulletin*, 5, pp. 18-24.

Royer, T. C. 1981. "Baroclinic transport in the Gulf of Alaska. Part II. Fresh water driven coastal current." *Journal of Marine Research*, pp. 251-266.

Rugh, D. J., Shelden, K. E. W., and Withrow, E. E. 1995. "Spotted seals sightings in Alaska 1992-93.", MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East West Highway, Silver Spring, MD 20910.

Salmon, J. E. 1992. "Conservation and Environmental issues affecting the shrimp industry." *Shrimp '92. Proceedings of the 3rd Global Conference on the Shrimp Industry*, Hong Kong, pp. 30-34.

Scheffer, V.B. 1950. The food of the Alaska fur seal. U.S. Fish and Wildlife Serv. Wildl. Leaflet, 39: 410-42.

Scheffer, V.B. 1980. Adventures of a Zoologist. Charles Scribners and Sons, New York, NY. 204 pp.

Scheffer, V. B., C. H. Fiscus, and E. I. Todd. 1984. History of scientific study and management of the Alaskan fur seal, Callorhinus ursinus, 1786-1964. U.S. Department of Commerce, NOAA Tech. Report NMFS SSRF-780. 70 pp.

Schumacher, J. D., and Kendall Jr., A. W. 1995. "Fisheries Oceanography: Walleye Pollock in Alaskan Waters." U.S. National Report to IUGG: 1991-1994; Reviews of Geophysics, *Supplement*. pp. 1153-1163.

Schumacher, J. D., Pearson, C. A., and Overland, J. E. 1982. "On exchange of water between the Gulf of Alaska and Bering Sea through Unimak Pass." *Journal of Geophysical Research*, 87, pp. 5785-5795.

Schumacher, J. D., and Stabeno, P. J. 1998. "The continental shelf of the Bering Sea. Chapter x." The Sea, A. R. Robinson and K. H. Brink, eds., John Wiley & Sons.

Sease, J. L., and Loughlin, T. R. 1999. "Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1997 and 1998." NOAA Technical Memorandum, *NMFS-AFSC-100*, U.S. Department of Commerce. p. 61.

Shaughnessy, P. D., and Fay, F. H. 1977. "A review of the taxonomy and nomenclature of North Pacific harbour seals." *Journal of Zoology (London)*, 182, pp. 385-419.

Shuntov, V. P. 1993. "Biological and physical determinants of marine bird distribution in the Bering Sea." The status, ecology, and conservation of marine birds of the North Pacific, K. Vermeer, K. T. Briggs, K. J. Morgan, and D. Siegel-Causey, eds., Canadian Wildlife Service and Pacific Seabird Group, pp. 10-17.

Sinclair, E. H., Antonelis, G. A., Robson, B. R., Ream, R., and Loughlin, R. 1996. "Northern fur seal, *Callorhinus ursinus*, predation on juvenile pollock, *Theragra chalcogramma*." NOAA Technical Report, *NMFS 126*, U.S. Department of Commerce, NOAA. pp. 167-178.

Sinclair, E. H., Antonelis, G. A., Robson, B. R., Ream, R. R., and Loughlin, T. R. 1997. "Norther fur seal predation on juvenile walleye pollock." NOAA Technical Report, *NMFS 126*, U.S. Department of Commerce, NOAA.

Sinclair, E. H., Loughlin, T., and Pearcy, W. 1994. "Prey selection by northern fur seals (*Callorhinus ursinus*) in the eastern Bering Sea." *Fishery Bulletin*, 92(1), pp. 144-156.

Smirnov, N. A. 1929. "A review of the Pinnipedia of Europe and northern Asia." *Izvestiya Tikhookeanskogo Nauchno-Issledovatel'skogo Instituta Rybnogo Khozyaistaca i Okeanografii*, 9, pp. 231-268.

Smith, K. R., and McConnaughey, R. A. 1999. "Surficial sediments of the eastern Bering Sea continental shelf: EBSSED database documentation." NOAA Technical Memorandum, *NMFS-AFSC-104*, U.S. Department of Commerce, NMFS Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115-0070. p. 41.

Springer, A. M., Roseneau, D. G., Lloyd, D. S., McRoy, C. P., and Murphy, E. C. 1986. "Seabird responses to fluctuating prey availability in the eastern Bering Sea." *Marine Ecology Progress Series*, 32, pp. 1-12.

Springer, A. M., Piatt, J. F., Shuntov, V. P., Van Vliet, G. B., Vladimirov, V. L., Kuzin, A. E., and Perlov, A. S. 1999. "Marine birds and mammals of the Pacific subarctic gyres." *Progress in Oceanography*, 43, pp. 443-487.

Springer, A. M., Roseneau, D. G., Lloyd, D. S., McRoy, C. P., and Murphy, E. C. 1986. "Seabird responses to fluctuating prey availability in the eastern Bering Sea." *Marine Ecology Progress Series*, 32, pp. 1-12.

Stabeno, P. J. and Reed, R. K., and Schumacher, J. D. 1994. "Circulation in the Bering Sea basin by satellite tracked drifters." *Journal of Physical Oceanography*, 24, pp. 848-854.

Sugimoto, T., and Tadokoro, K. 1997. "Interannual-interdecadal variations in zooplankton biomass, chlorophyll concentration and physical environment in the subarctic Pacific and Bering Sea." *Fisheries Oceanography*, 6, pp. 74-93.

Swain, U. G., and Calkins, D. G. 1997. "Foraging behavior of juvenile Steller sea lions in the northeastern Gulf of Alaska: Diving and foraging trip duration." Unpublished report,, Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK. pp. 91-106.

Swartzman, G. L., and Haar, R. T. 1983. "Interactions between fur seal populations and fisheries in the Bering Sea." *Fishery Bulletin*, 81, pp. 121-132.

Swartzman, G. L., C. A. Ribic, and C. P. Haung. 1990. Simulating the role of entanglement in northern fur seal, *Callorhinus ursinus*, population dynamics. Pp. 513-530, *In* R. S. Shomura and M. L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-154.

Thompson, G., and Dorn, M. 1998. "Pacific cod." Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea and Aleutians Islands region, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252, p. 77.

Thompson, G. G., Zenger, H. H., and Dorn, M. W. 1994. "Assessment of the Pacific cod stock in the Gulf of Alaska." Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska, Gulf of Alaska Plan Team, ed., North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501-2252, pp. 105-184.

Trenberth, K. E., and Hurrell, J. W. 1994. "Decadal atmosphere-ocean variations in the Pacific." *Climate Dynamics*, 9, pp. 303-319.

Trites, A. W. 1992. "Northern fur seals: Why have they declined?" *Aquatic Mammals*, 18(1), pp. 3-18.

Trites, A. W., Livingston, P. A., Vasconcellos, M. C., Mackinson, S., Springer, A. M., and Pauly, D. 1999. "Ecosystem change and the decline of marine mammals in the Eastern Bering Sea: testing the ecosystem shift and commercial whaling hypotheses." Fisheries Centre Research Reports 1999, *Vol. 7*, University of British Columbia. p. 100.

Vining, I. 1995. "Traditional Knowledge on Ecosystem Changes." Ecosystem Considerations for 1995, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501, p. 61.

Vining, I. 1998. "Anecdotal information from the fishing fleet, coastal communities, and various agencies." Ecosystem Considerations for 1998, North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501, p. 54.

Wade, P. R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walsh, J. J., McRoy, C. P., Coachman, L. K., Georing, J. J., Nihoul, J. J., Whitledge, T. E., Blackburn, T. H., Parker, P. L., Wirick, C. D., Shuert, P. G., Grebmeier, J. M., Springer, A. M., Tripp, R. D., Hansell, D. A., Djenidi, S., Deleersnijder, E., Henricksen, K., Lund, B. A., Andersen, P., Muller-Karger, F. E., and Dean, K. 1989. "Carbon and nitrogen recycling with the Bering/Chukchi Seas: source regions for organic matter effection AOU demands of the Arctic Ocean." *Progress in Oceanography*, 22(4), pp. 277-359.

Wespestad, V.G., J.N. Ianelli, L. Fritz, T. Honkalehto, N. Williamson, and G. Walters. 1997b. Bering Sea-Aleutian Islands walleye pollock assessment for 1998. *In* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1998. Bering Sea/Aleutian Islands Plan Team, eds., pp. 35-120. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501).

Wespestad, V., and Dawson, P. 1992. "Walleye pollock." Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions as projected for 1993, Bering Sea/Aleutian Islands Plan Team, ed., North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501, pp. 1-1 to 1-32.

Wespestad, V. G., and Terry, J. M. 1984. "Biological and economic yields for eastern Bering Sea walleye pollock under differing fishing regimes." *North American Journal of Fisheries Management*, 4, pp. 204-215.

Whitledge, T. E., Reeburgh, W. S., and Walsh, J. J. 1986. "Seasonal inorganic nitrogen distributions and dynamics in the southeastern Bering Sea." *Continental Shelf Research*, 5, pp. 109-132.

Withrow, D. E., and Loughlin, T. R. 1996. "Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) along the north side of the Alaska Peninsula and Bristol Bay during 1995.", MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East West Highway, Silver Spring, MD 20910.

Wolotira Jr., R. J., Sample, T. M., Noel, S. F., and Iten, C. R. 1993. "Geographic and bathymetric distributions for many commercially important fishes and shellfishes off the west coast of North America, based on research survey and commercial catch data, 1912-1984." NOAA Technical Memorandum, *NMFS-AFSC-6*, U.S. Department of Commerce, NOAA. p. 184.

Wyllie-Echeverria, T., and Wooster, W. S. 1998. "Year-to-year variations in Bering Sea ice cover and some consequences for fish distribution." *Fisheries Oceanography*, 7, pp. 159-170.

Wynne, K., Hicks, D., and Munro, N. 1991. "1990 salmon gillnet fisheries observer programs in Prince William Sound and South Unimak, Alaska." Final Report,, Saltwater, Inc., Anchorage, AK.

Wynne, K. M., D. Hicks, and N. Munro. 1992. 1991 Marine mammal observer program for the salmon driftnet fishery of Prince William Sound Alaska. Annual Rept. NMFS/NOAA Contract 50ABNF000036. 53 pp. NMFS, Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, AK 99802.

York, A. E. and C. W. Fowler. 1992. Population assessment, Pribilof Islands, Alaska. Pp. 9-26, *In* H. Kajimura and E. Sinclair (eds.), Fur seal investigations, 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-2.

York, A. E., J. D. Baker, R. G. Towell, and C. W. Fowler. 1997. Population assessment, Pribilof Islands, Alaska. Pp.9-28, *In* E. H. Sinclair (ed.), Fur seal investigations, 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-87.

York, A. E., R. G. Towell, R. R. Ream, J. D. Baker, and B. W. Robson. 1998. Population assessment, Pribilof Islands, Alaska. Pp.9-28 *In* B. W. Robson (ed.), Fur seal investigations, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-113, 101p.

York, A. E. 1987a. Northern fur seal, Callorhinus ursinus, eastern Pacific population (Pribilof Islands, Alaska, and San Miguel Island, California). In J. P. Croxall and R. L. Gentry (editors), Status, biology, and ecology of fur seals, p. 9-21. U.S. Department of Commerce, NOAA Tech. Report NMFS 51. 73 pp.

York, A. E. 1987b. On comparing the population dynamics of fur seals, pp. 133-140 ill J. P. Croxall and R. L. Gentry (Eds.), Status, biology, and ecology of fur seals. U.S. Department of Commerce, NOAA Tech. Report NMFS 51. .

York, A. E. 1991. Relationship between sea surface temperature and survival of juvenile male northern fur seals. pp. 94-106 ill F. Trillmich and K. Ono (Eds.), Pinnipeds and the 1982-83 EI Nino in the North Pacific. University of California Press, Berkeley, California.

York. A. E., and J. R. Hartley. 1981. Pup production following harvest of female northern fur seals. Can. J. Fish. Aquat. Sci. 38: 84-90.

York, A. E., and P. Kozloff. 1987. On the estimation of numbers of northern fur seal,
Callorhinus ursinus, pups born on St. Paul Island, 1980-86. Fish. Bull. 85: 367-375.

Zheng, J., Kruse, G. H., and Murphy, M. C.1998. “"A Length-based approach to estimate population abundance of Tanner crab, *Chionoecetes bairdi*, in Bristol Bay, Alaska" in *Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management*.” *Canadian Special Publication of Fisheries and Aquatic Sciences*, 125, pp. 97-105.

8.0 LIST OF PREPARERS

David R. Cormany
P. Michael Payne
Protected Resources Division
NMFS Alaska Region
Anchorage, Alaska 99513

David Cormany, Fishery Biologist, and coordinator of the Northern Fur Seal and Pribilof Islands Program for NMFS, Alaska Region, Anchorage, Alaska.

P. Michael Payne, Assistant Regional Administrator for Protected Species, NMFS, Alaska Region, Juneau, Alaska.